POWER

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TWO and seven-score years ago
The voice of a fearless people spoke
In trumpet tones to the British foe
And Freedom trampled the tyrant's yoke;
But now, where War with its sweeping tide
Engulfs the world in a bloody wrack,
Their flags are fluttering side by side—
The Stars and Stripes and the Union Jack.

The old suspicions that roused our fears,
The fires that ancient grudges fed,
Are smothered deep in the peaceful years
And all the doubt and distrust are dead;
For Yank and Britisher hand to hand
Have crushed the force of the Hun's attack,
And ties of a common cause have spanned
The Stars and Stripes and the Union Jack.

This is no time to bring to life
Long-buried wrongs till they sting and smart,
Or wake once more a forgotten strife
To serve the ends of a knavish heart.
Who lifts his voice in a baseless claim
Or trails along with the yelping pack
Is a renegade, and he puts to shame
The Stars and Stripes and the Union Jack.

This is a day to pledge anew
Our hearts, our lives, and our very all
To the mighty task we shall carry through
Till earth is freed from the despot's thrall;
Till the glorious day when our hosts advance
To sweep the hordes of the vandals back,
Led on by the three-hued flag of France,
The Stars and Stripes and the Union Jack.

Soot Blowers for Horizontal Water-Tube Boilers

Of the five makes of blower serving this type of boiler, three are of trans-setting design with nozzles pointing directly downward or along the diagonal spaces between the tubes. In the other two designs the nozzles are at the side wall and blow horizontally between the tubes.

IN A previous article were given the advantages of the mechanical removal of soot over hand cleaning, and data dealing with the blower in service. As a continuation it may be of interest to dwell briefly on the different types of mechanical blower on the market and their application to the various boilers in use. There is no standard blower that may be applied indiscriminately to all makes of boiler. Blowers have been developed by five different manufacturers for horizontal boilers of the B. & W. type; different designs have been applied to hollow stay-bolt boilers such as the Heine; and for Stirling boilers and certain vertical types, special applications have been made. A large percentage of the water-tube boilers served by mechanical blowers belong to the first classification, and to them the present article will be limited. For these boilers each of the five manufacturers has developed a distinctive blowing unit. Local conditions, size of boiler and the arrangement of baffles determine the number of units employed and their location. All receive their steam from a common supply pipe and are manipulated in sequence in the direction of the draft. One design of unit extends across the setting with nozzles directing the steam jets directly downward be-

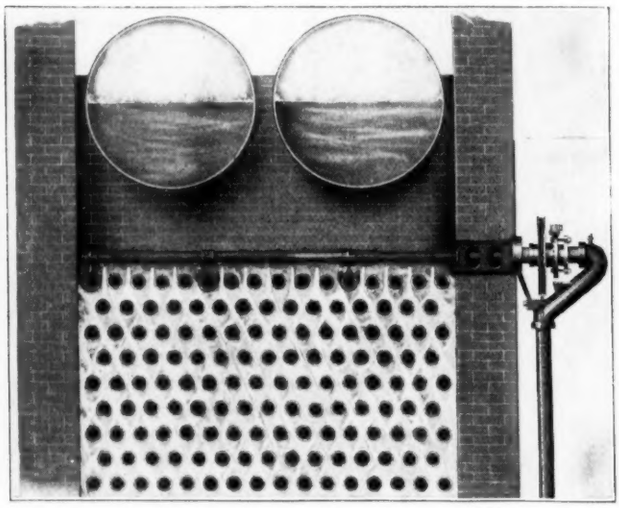


FIG. 1. DIAMOND REVOLVING UNIT FOR HORIZONTAL WATER-TUBE BOILER

tween the tubes of the top row. The blowing element is mounted on bearings in the side walls and is rotated by a chain and sheave outside the setting. Two other designs follow the same general arrangement, but the nozzles direct the steam along the diagonal paths between the tubes at an angle of about 60 deg. to the horizontal. The fourth and fifth types consist of a series of nozzles at the side wall, directing the steam horizontally across the setting between the tubes.

The blower first mentioned is made by the Diamond Power Specialty Co. It is known as "Model G" and is applicable to nearly 90 per cent. of the installations made by the company. The perpendicular jet is standard with the company, as it is considered more effective, but upon demand, diagonal jets are supplied. Fig. 1 shows a unit of the perpendicular type installed in a horizontal water-tube boiler. The general arrangement,

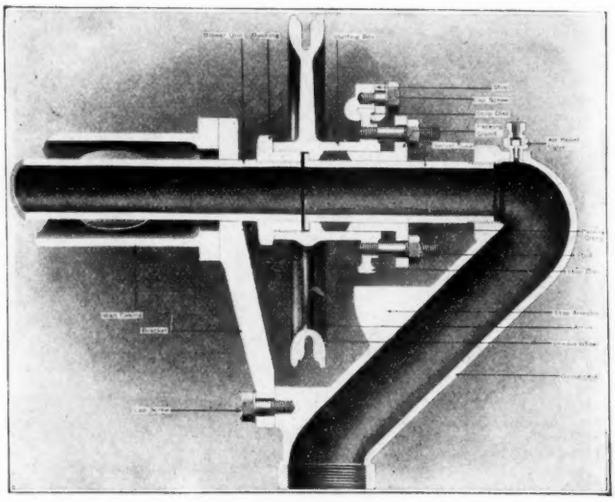


FIG. 2. SECTION THROUGH DIAMOND "MODEL G" SOOT-BLOWER HEAD

relative position of nozzles and tubes and the distribution of the steam over the tube surface will be apparent. The blower consists of five principal elements, the head, Fig. 2, being the foundation element to which the others are attached. Next in order is the wall box, which is bricked into the setting and is so constructed that the blower can be turned freely without admitting air into the setting. The rotation is effected by a sheave from which suspends a chain within reach of the boiler-room floor. The blowing element runs crosswise of the tubes and at intervals is supported by bearings clamped to the tubes. Jets of steam from the nozzles pass downward between the tubes of the first row and in striking the staggered tubes off center are deflected to the diagonal paths indicated. Features of construction are an adjustable packing gland on the head, a gooseneck to bring the steam line close to the boiler wall, automatic stops to limit the revolution of the blowing element and an air relief valve at the top of the gooseneck to automatically admit air to the blowing element after the steam is shut off. The valve operates at atmospheric pressure and, in destroying the vacuum that would be formed upon the condensation of the steam in the element, tends to obviate the corrosion that would result if the furnace gases were drawn by the vacuum into the piping. Drainage of the system is effected by hand-operated valves.

The use of "Insoluminum" (calorized iron) in the blowing elements located in the high-temperature zones is a feature made much of by the manufacturer. The metal is reported to withstand temperatures up to

1800 and 2000 deg. F., and is not affected by sulphur dioxide and carbon monoxide in the percentages in which they occur in furnace gases, unless the outer coating is penetrated. Composed of a metal with these properties, a choice of location is open to the blowing element. It may be placed near to the surface it is to serve with less regard to the direct heat from the furnace. This is of particular importance when the blowing element is to be placed near the fire to keep down the troublesome clinker formation on the lower tubes.

Previous to the adoption of "Insuluminum," protection of the blowing element was important. The illustrations in Fig. 3 show successive steps over a period of years. No. 1, the original element, was a plain

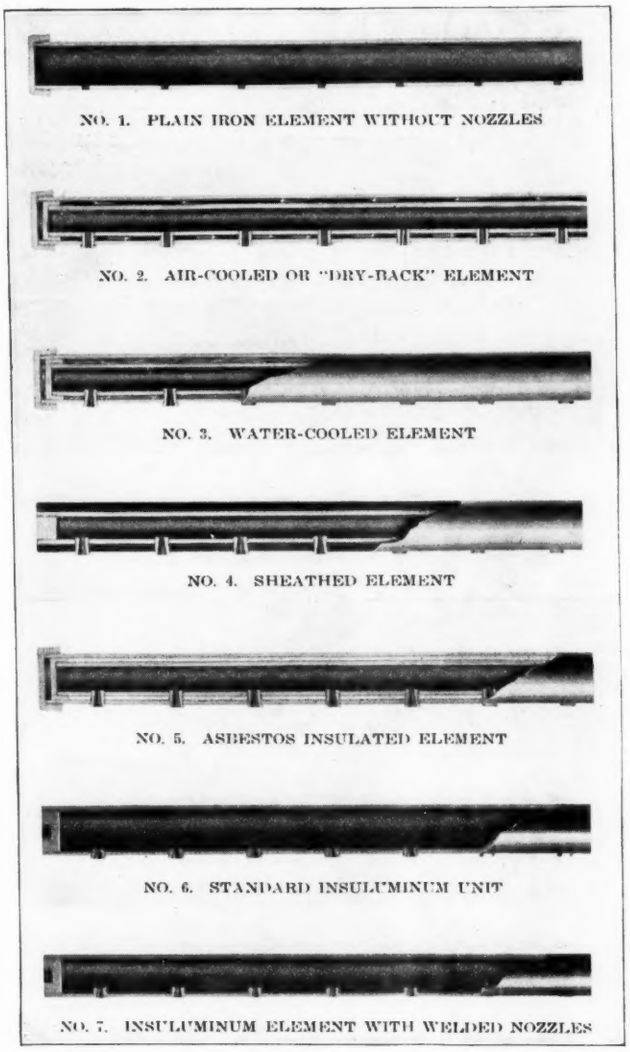

NO. 1. PLAIN IRON ELEMENT WITHOUT NOZZLES
NO. 2. AIR-COOLED OR "DRY-BACK" ELEMENT
NO. 3. WATER-COOLED ELEMENT
NO. 4. SHEATHED ELEMENT
NO. 5. ASBESTOS INSULATED ELEMENT
NO. 6. STANDARD INSULUMINUM UNIT
NO. 7. INSULUMINUM ELEMENT WITH WELDED NOZZLES

FIG. 3. DEVELOPMENT OF DIAMOND BLOWER ELEMENTS

iron pipe with holes drilled in it. The pipe deteriorated rapidly, and the jets of steam did not have sufficient radius of action. No. 2, an air-cooled element, soon superseded the original design. To form the air space, consisted of concentric iron pipes. Parallel-wall nozzles were used for the first time. This was followed by a water-cooled element, using diverging or venturi nozzles. In the search for improvement a heavy sheathing around the blowing element was next tried, and this in turn was replaced by concentric pipes with an insulating filler of asbestos between. The double pipes made the over-all diameter too great for certain locations in the boiler, and to keep down the size there was the tendency to make the inner pipe too small to meet the demand for steam. The weight was greater

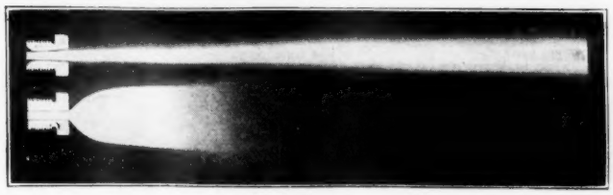


FIG. 4. COMPARISON OF JETS FROM EXPANDING AND PARALLEL-BORE NOZZLES

than that of a single pipe, and as the outer pipe deteriorated, exposing the inner element, the longevity was not greatly increased.

Insuluminum, with its high heat-resisting properties, permitted a return to the single pipe with venturi nozzles screwed into the metal wall of the tube. A further refinement, recently conceived, is the welding of these nozzles into the tube flush with the outer surface.

The advantage claimed for the venturi nozzle is to increase the velocity of the jet and concentrate its action in lines parallel to the axis of the nozzle. Fig. 4 is a Diamond illustration, comparing the jet produced to that from a parallel-bore nozzle. The effective radius

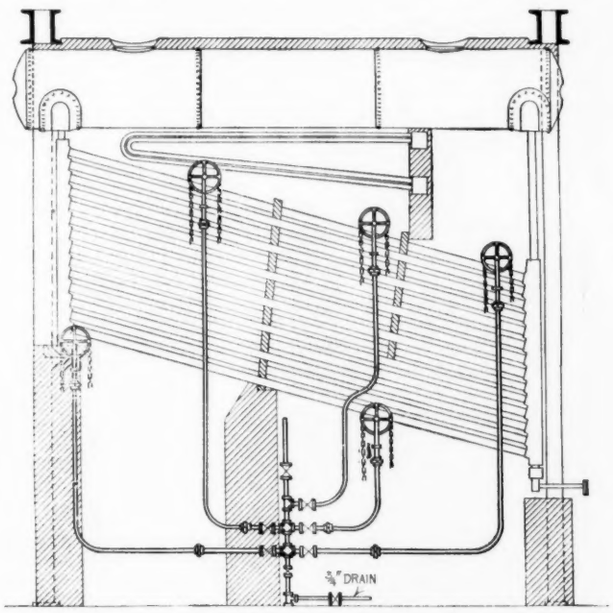


FIG. 5. STANDARD DIAMOND FIVE-UNIT INSTALLATION ON BOILER OF B. & W. TYPE

of the jet is increased without augmenting the steam consumption. Smaller jets may be used, and the number of units required to clean the boiler will be minimized. With the nozzle gradually enlarging in proportion to the expansion of the steam, the static energy due to pressure is converted into kinetic energy or velocity. Naturally, the degree of nozzle divergence depends upon the initial and terminal pressures, so that nozzles of different proportions are required to suit the blowing pressure.

Application of a standard five-unit installation on a

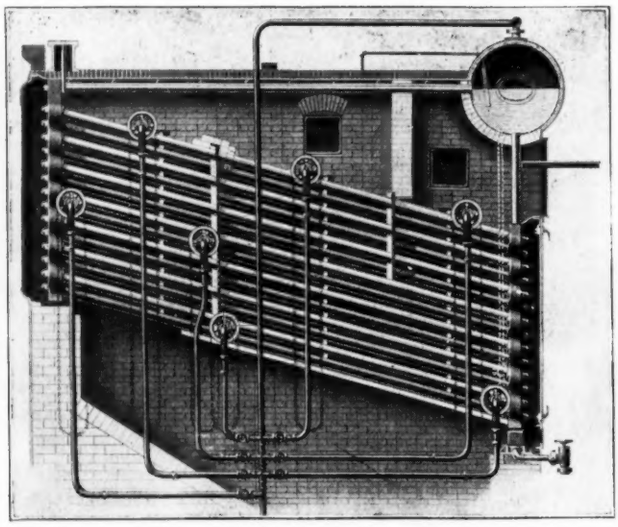


FIG. 6. DIAMOND SOOT BLOWER ON B. & W. CROSS-DRUM BOILER

three-pass vertically baffled horizontal water-tube boiler is shown in Fig. 5. It will be noticed that there is a blowing unit for each pass, another is placed to keep clinker formation off the lower tubes above the furnace, and the fifth unit serves the combustion chambers. This arrangement, of course, does not apply to every boiler of similar size and general type. Differences in baffle design and location and many other factors enter into the blower layout. Fig. 6 shows the layout on a cross-drum boiler. As before, there is a unit at the top of each pass, two additional units in the first pass to take care of the lower tubes with which the gases first come in contact and two more at the lower corners of the second and third passes, where soot would be liable to gather. In each case a vertical steam header supplies the various units. The advantages that are claimed for this construction are easy drainage, a shorter header, free expansion for the risers and concentration of the valves in the various lines at one poiint. Where the boilers are set in a solid battery, the geared installation shown in Fig. 7 is used. The blowing element is the same, but it is turned by means of gearing, a long stem and an operating handle at the top of the setting. As indicated in the illustration, the stem is inclosed in the pipe supplying steam to the unit.

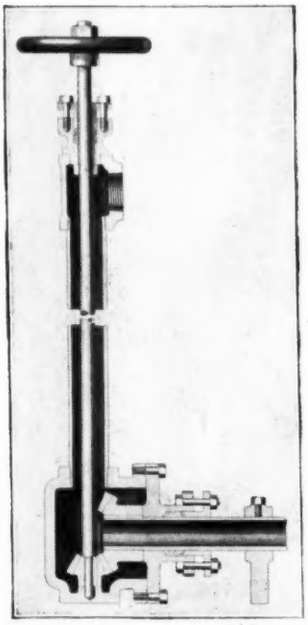


FIG. 7. SECTION OF GEARED SOOT-BLOWER HEAD

The Vulcan Soot Cleaner Co.'s method of removing the soot from horizontal vertically baffled water-tube boilers is illustrated in Fig. 8. As in the previous case, the blowing element extends across the setting and is supported by bearings clamped to the tubes of the upper row. The element is mounted on bearings and is rotated through an arc of 180 deg. by a chain and sprocket outside of the setting. The nozzles are directed along the diagonal paths between the tubes at an angle of about 60 deg. to the horizontal. When the nozzle is pointing directly downward, the jet is in line with its particular path and the steam is distributed at high velocity to the lower tubes. This is made possible by the use of special machine-made diverging nozzles proportioned so that steam will reach the distant parts of the heating surface in sufficient volume to remove the soot. As the element is revolved, the direction of the nozzle changes, owing to the fact that it is set at an angle on the element, so that the jet leaves the lower tubes and concentrates on the new row higher up. Because of the change in direction the steam jet tends to clean the tubes lengthwise as well as around the circumference. Continued revolution of the element brings the jet successively from row to row, and as it approaches the top the lengthwise action increases, so that there is no direct impingement on the tubes. The nozzles are placed between every other row of tubes, as it is the practice to use two elements per pass, one blowing down the diagonals in one direction and the other down the opposing diagonals.

The elements are placed in the comparatively cool pockets of the boiler and, in addition to being so located, are further protected by means of special sheathing made sectionally with overlapping joints so as to take care of any expansion or contraction. This metal sheathing has high heat-resisting qualities and is particularly adapted to resist warping under high tempera-

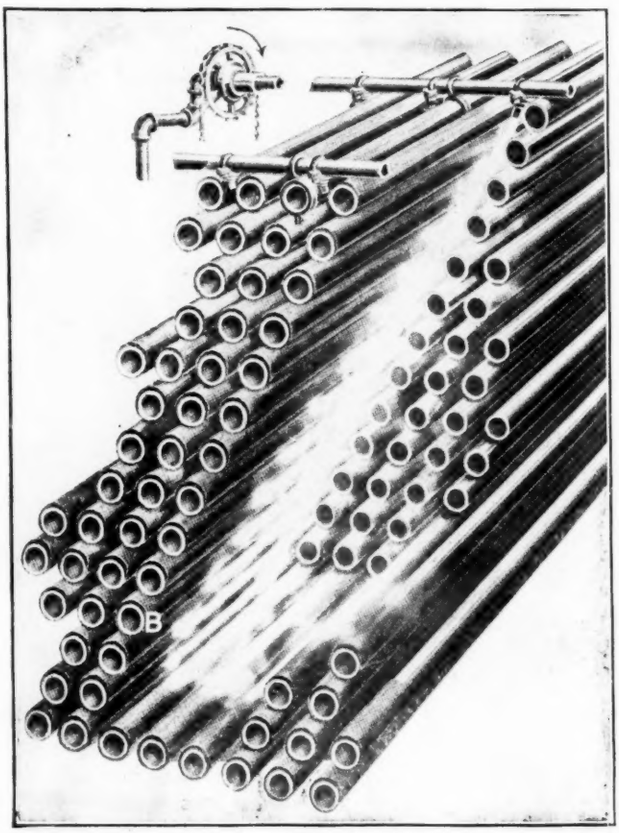


FIG. 8. VULCAN PRINCIPLE OF CLEANING VERTICALLY BAFFLED WATER-TUBE BOILERS

tures. This is important, as distortion of the element is one of the most objectionable features in connection with mechanical soot blowers of the trans-setting type.

Fig. 9 shows a standard installation with two elements per pass and an extra element for the superheater. Where conditions are suitable, one element is used per pass and, as shown in Fig. 10, both sets of nozzles are mounted on this element. In some cases a stationary system is preferable. In this event the elements carry multiple nozzles containing two or three individual nozzles, which point radially to cover a wide arc. Steam is blown down the diagonals in a number of directions to duplicate the effect of rotating the single nozzle. The paths of discharge of the steam cross one another,

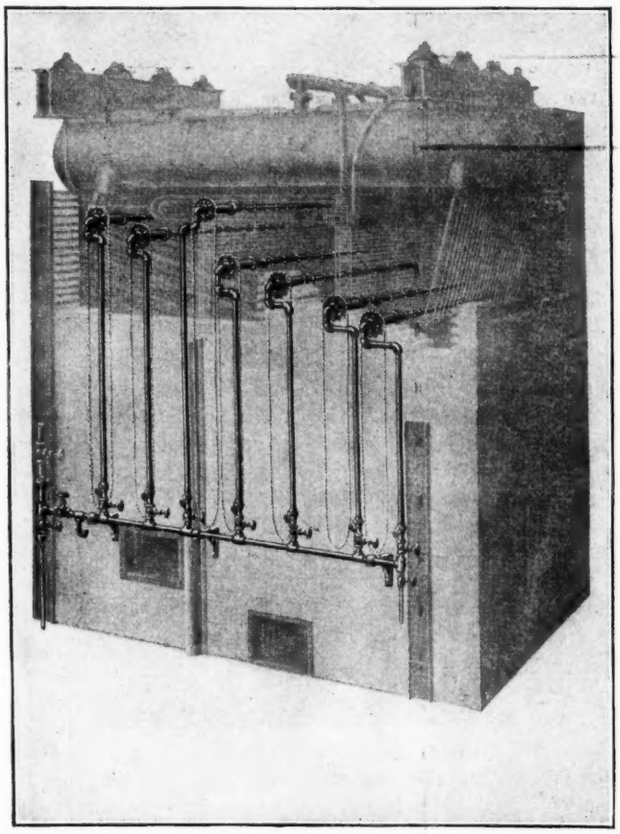


FIG. 9. TYPICAL VULCAN INSTALLATION

so that the surface is cleaned from more than one direction. Combinations of rotating and stationary elements are also used, the particular combination depending on the arrangement of the baffling and conditions.

A blower installation on boilers of the Heine or Keeler type is shown in Fig. 11. It consists of rotatable elements discharging jets of steam through the diagonal spaces between the tubes as in the case of boilers of the B. & W. type. These elements are placed in line with the upper baffle and are bridged over by cast-iron housings to make the baffle tight. Both the upper and lower baffles are cleaned of soot by the stationary perforated elements indicated.

A nozzle of the rotatable diagonal type is shown in Fig. 12. It is of the expanding design where the maximum cleaning effect is required at a distance. Where a spreading effect closer to the discharge is needed, nozzles of parallel-bore design are used, and for special conditions converging nozzles may be more suitable. Fig 13 shows a nozzle plug containing three discharge nozzles, as designed for the stationary type of element.

Close inspection of Fig. 9 will show above the valve in each riser, a small air-relief valve. It consists of an automatic ball-check valve held to its seat by the pressure of the steam. As soon as the main valve is closed, shutting off the steam from the blowing element, the

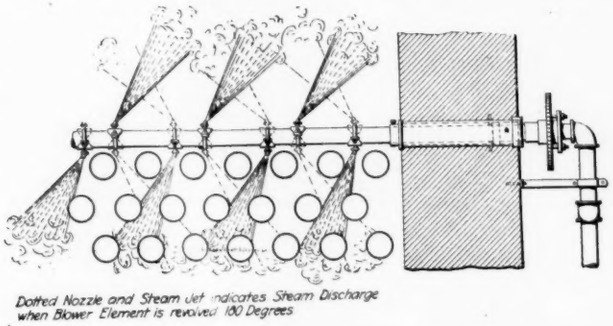


FIG. 10. NOZZLES ON ONE ELEMENT BLOWING BOTH DIAGONALS

ball falls away from its seat, admitting sufficient air to restore the balance of pressure. The installation of such a device is to prevent furnace gases laden with sulphur dioxide from being drawn into the piping. Condensation of the steam after the riser valve had been closed, created a vacuum into which the furnace gases were forced, and their mixture with the moisture on the inner surface of the piping formed sulphuric acid. The air-relief valve prevents the formation of the vacuum and obviates the serious erosion of the metal.

Another feature of the Vulcan system is the use of an automatic telltale drain valve on the header to insure dry steam. It operates on the same principle as the air-relief valve, but is larger. In Fig. 9 it is

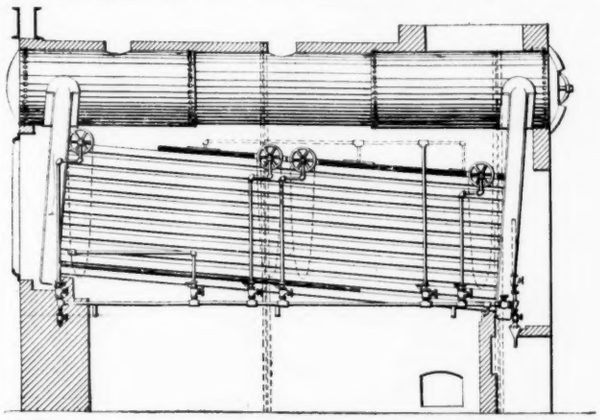


FIG. 11. VULCAN SOOT CLEANER ON HORIZONTALLY BAFFLED BOILER OF HEINE OR KEELER TYPE

indicated at the left of the header. When the valve through which steam passes to the system is closed, the ball falls away from its seat, and if there is any condensation from the steam that remains or that may leak through from the main supply, it is at once indicated and will drain out. This serves as a notice to the operator that he has not left his controlling and drain valves in the proper positions or that the valves are leaking and need attention. This is important, for if condensation is admitted into the blow lines to be discharged upon the tubes, it will cause a soot scale that bakes hard and cannot be removed by a mechanical cleaner.

The principle of operation of the Marion Planet soot blower, now made by the Marion Machine, Foundry and Supply Co., is much the same as that of the preceding blower. It is a trans-setting blower with nozzles directed down the diagonals between the tubes. The nozzles are of the internal type welded to the element. As shown in Fig. 14, there is a nozzle for every other space, and with an element at each end of the pass above the tubes, both diagonals are covered. For upright inclined even-spaced tubes, for vertical boilers and in the last pass of small horizontal boilers, perpendicular nozzles are employed. As usual, the element is operated by a sprocket and chain within reach of the floor. There are a suitable wall casing, supporting bearing, flanges and an outside receiving chamber for the steam. Each element is piped to a horizontal header, and drainage is effected through a hand-operated valve.

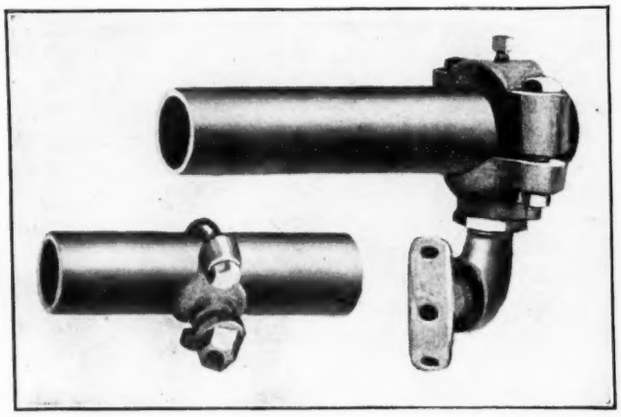


FIG. 12. LOWER VIEW, VULCAN NOZZLE FOR ROTATABLE ELEMENT. FIG. 13. UPPER VIEW, VULCAN MULTIPLE-WAY NOZZLE FOR STATIONARY ELEMENT

The blower made by the Bayer Steam Soot Blower Co., for horizontal vertically baffled water-tube boilers, is constructed on an entirely different principle from the blowers previously described. It was conceived with the idea that as soot collects mostly on the top of the tubes, the most effective way to remove it is to direct jets of steam horizontally across the tubes to carry it off by direct impact and on the reverse sides of the tubes by the expansion of the steam. As in the case of the other blowers, it is made up of distinct units for each pass equipped with as many nozzles as there are horizontal spaces between the tubes. The nozzles, which are collectively under the control of a single lever within reach of the floor, are given an oscillating motion following the planes of the tubes. Fig. 15 shows the application to a vertically baffled three-pass water-tube boiler.

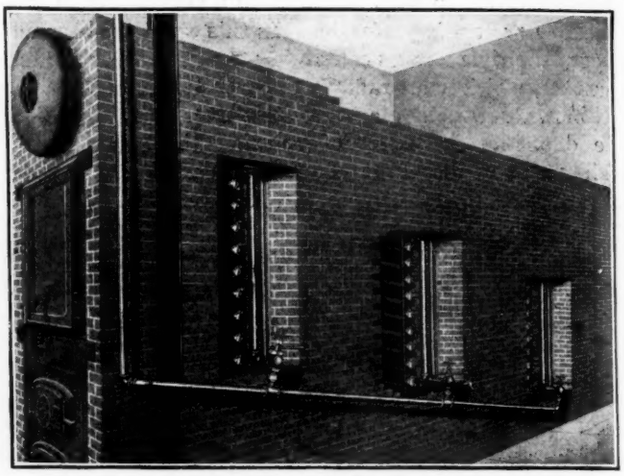


FIG. 15. BAYER SOOT BLOWER FOR VERTICALLY BAFFLED WATER-TUBE BOILER

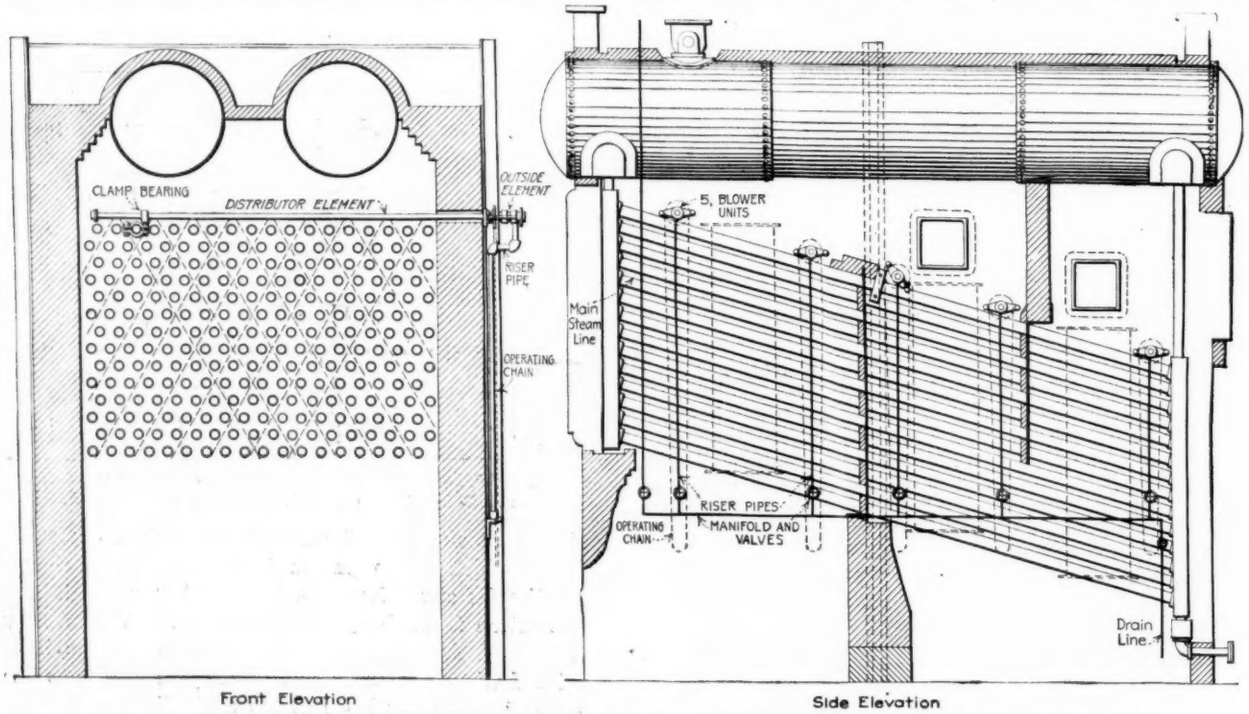


FIG. 14. MARION PLANET SYSTEM FOR HORIZONTAL VERTICALLY BAFFLED WATER-TUBE BOILER

The units are designed to fit the cleaning pockets originally provided along the side walls for hand cleaning, a cover shield closing the opening so that it is air-tight. Each element receives steam from a supply

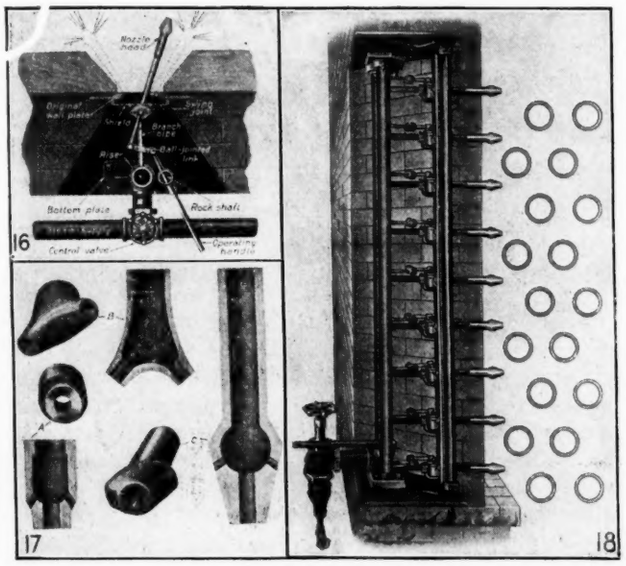


FIG. 16. SECTION THROUGH BAYER UNIT. FIG. 17. BAYER NOZZLES FOR VERTICALLY-BAFFLED BOILERS
FIG. 18. ELEVATION OF UNIT

pipe common to all and is provided with a drain at the low point to insure dry steam from the nozzles. The manufacturer states that the efficiency of the system should not be gaged by the work of the hand lance with its single jet, as more efficient results are obtained from a multiplicity of jets in action at the same time.

Views of one of the units are shown in Figs. 16 and 18. From a central riser connecting with the steam line, short branches, one for each nozzle, extend inward to swing joints bolted to the cover shield. The moving member of each joint connects with the nozzle heads within the setting. A vertical rockshaft provided with a single handle connects with the moving members of the swing joints through the sets of levers indicated in the illustration. The swing joints are set so that their axes are at right angles to the pitch of the tubes, and ball joints on each end of the connecting links prevent binding action due to the inclination. Steam going to the entire series of nozzle heads, is injected into the space between the tubes for the full length of the pass.

Fig. 17 shows the various designs of nozzle used for this service. Nozzle *A* is the standard type used in the second and third passes. It is designed to produce one main and two auxiliary sidewise jets in the plane of oscillation. The main jet does the major part of the work, and the auxiliary sidewise jets take care of the near corners. Nozzle *B* is a special type producing two equal jets, which is used to advantage under certain fuel and combustion conditions. Nozzle *C* is the standard for the first pass. It is heavier than *A* and will better withstand the intense heat from the furnace. As an additional safeguard it is common practice to corbel out the brickwork for about four inches under the nozzles of the first pass to deflect the gases and prolong the life of the lower nozzles. In the limiting position at either side—the normal location when the blower is inoperative—the nozzle heads are brought back nearly flush with the furnace wall, so that they are out of the strongest currents of the gases and are protected.

Another soot blower from which the steam is directed horizontally between the tubes is made by the Monarch Soot Remover Co. Fig. 19 shows the general design. There is an element for each pass. It is set within the dusting door, and a two-panel shield flush with the outer face of the side wall covers it up and prevents entrance of cold air into the boiler setting. The blowing element consists of a standpipe supplying steam to the nozzles, one for every horizontal space between the tubes, gearing by which the nozzles are turned and means of protecting the nozzles from the furnace heat when the blower is not in operation. The nozzles are operated by a chain and sprocket wheel through a worm-gear reduction to an operating rod carrying a gear for each nozzle. The member on which the nozzle rotates is screwed into the standpipe and its horizontal axis is set at the same inclination as the tubes, so that the steam jet will hold to its respective space throughout the arc of nozzle rotation. On large boilers one-half of the nozzles are operated at a time.

Dust door frames lined with firebrick protect the blower from the heat of the furnace. Hinged shutters 15 in. long protect the nozzles. They are closed when the blower is inoperative, but readily open when the nozzles are rotated into the tube space. The nozzles are exposed to the hot gases only when in operation, and at this time the steam, being at a lower temperature than the gases, tends to keep them cool.

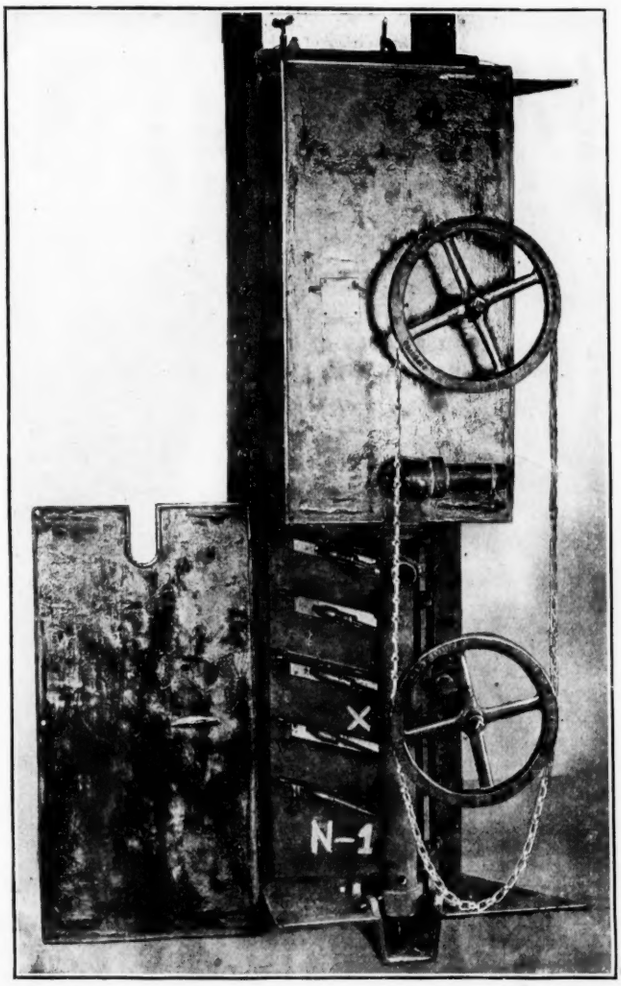


FIG. 19. A MONARCH ELEMENT WITH NOZZLES PASSING THROUGH SHUTTERS

Gaskets for Steam-Pipe Lines

By ZENO SCHULTES*

Some interesting facts regarding packing for steam lines, etc. Reasons are given why flanged pipe joints leak, such as rough flange faces, large bolt holes and holes spaced too far apart.

THE definition of a gasket as given by the dictionary is pleated hemp or tallowed rope for packing pistons, making pipe joints, etc.; metal packing or any composition for the same purpose. From this it will be seen, as is well known, that there are a large number of packing gaskets in existence, and their use dates back some years before the Christian era. For instance, history tells us that Hero, of Alexandria, Egypt, 130 years B. C., used as a packing for joints dry grass mixed with a little "gum water" and then sprinkled with sand.

The first real trouble with gaskets was had by Thomas Savery, about 1697, who in operating his pumping engine found it no easy matter to deal with what was then high-pressure steam. He complained that it melted his packing and forced him "to be to the pains to have all his joints soldered with spelter." Thomas Newcomen, who invented his atmospheric engine in 1705, says:

> It seemed as though at first the engine would be a failure, not because of the theories, but from other causes almost impossible to remedy. The derision of inventors forced me to seek outside assistance and then it was discovered that the trouble was with leaky joints. We invented as a gasket a combination of an old hat, a piece of leather and some cords, which answered the purpose quite well.

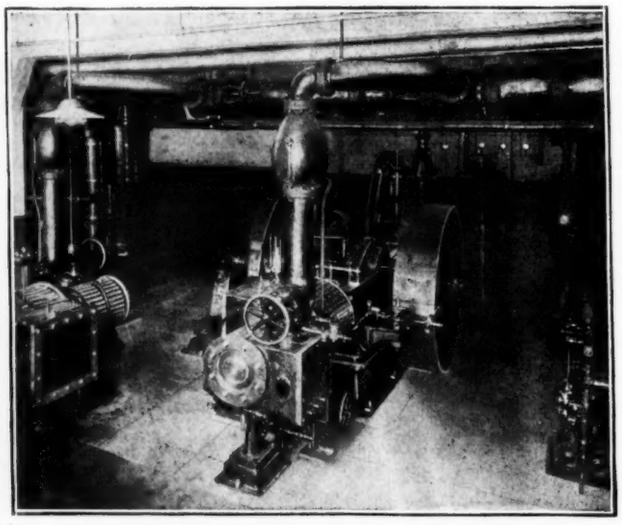


FIG. 1. A PIPING JOB WITH MANY JOINTS

In 1720 the Leapold engine came into use, and here also the serious problem was to prevent the leakage of steam. The heat at the leaky joint prohibited the use of such means of packing as had been formerly used on water-pipe joints, and it was only after considerable experimenting and almost complete loss of hope that Leapold got a packing in the form of a flaxen cord which he stuffed into the joint, and which proved satisfactory.

James Watt patented his engine in 1769 and said in his specifications: "I employ oils, wax, resinous bodies, fats of animals, quicksilver and other metals in their fluid state to render the piston and other parts of the engine air- and steam-tight."

At a meeting in 1914 of the Engineers Club of Boston several old and successful engineering veterans spoke about boiler-room practice. One of these, Capt. Charles Manning, told his experiences back in 1861. While he served as apprentice at one of the Baltimore engine works, his first job was to run the power plant. The engine, he said, could hardly be found in the engine room on account of the cloud of steam that hissed from leaky joints and stuffing-boxes and enveloped the engine. At that time sheet rubber had come into limited use, but was considered too expensive. One year later he tried one of the first sheets of asbestos packing ever made in this country.

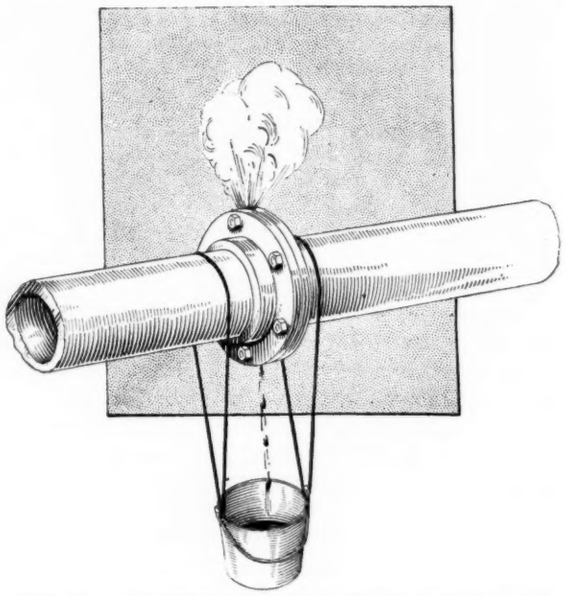


FIG. 2. A SLOPPY WAY OF CARING FOR A LEAK

George H. Diman, consulting engineer, spoke about the conditions existing 50 years ago in New England mills. Among other things he mentioned was that all the piping was of cast iron and that all joints were put together with red lead. From the foregoing it will be seen that engineers of the old days had their troubles even though the steam pressure was exceedingly low as compared with present-day practice.

The reason why a better gasket is needed than in former years is because of the rapidly increasing use of high-pressure and superheated steam. Engineers have learned—and paid well for the knowledge—that certain kinds of packing disintegrate and become worse than useless by the action of high-pressure and highly superheated steam. One cause of trouble in keeping flanged joints tight in pipe lines is because of the poorly finished and rusty flange surfaces, with which the best

*President Goetze Gasket and Packing Co.

common packing brings but temporary relief. A plant originally designed to operate with high-pressure steam should have its steam mains correctly laid out and designed so that the strain on the system when under pressure will be at a minimum. It frequently happens that a plant that has been designed to carry a certain pressure will be made later on to carry an increased working pressure, without giving due consideration to the fact that with hotter steam the pipe will expand more than when called upon to carry steam at the former pressure, or with no superheat. Under such conditions the plant that is properly laid out to carry a certain steam pressure today will not be capable of caring for the service tomorrow, when it may be decided to carry still higher pressure and a higher superheat.

Condensation in the main steam pipe is likely to produce water-hammer, which in turn causes vibration and thus tends to loosen the joints unless the gasket is elastic enough to take care of such contraction and expansion. Fig. 1 illustrates a pipe line that, because of the numerous joints, would be likely to give trouble from leakage unless suitable gaskets were used in the flanged joints.

Leaks also occur at flanges where the bolt holes are so large that only the corners of the square-headed bolts catch on the edge of the holes, thus making an insecure joint. Leakage sometimes occurs on account of the bolts being too few and too far apart. The probabilities are that there are more steam leaks in a plant than the engineer realizes. As an instance, one factory superintendent counted more than a hundred steam leaks in his plant. It does not take very many small leaks to make the equivalent of a large one which, should it occur, would be so self-evident that the engineer would take immediate steps to correct the same.

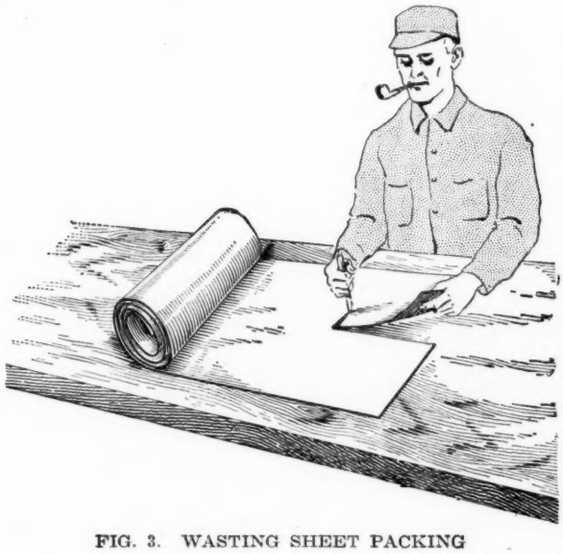


FIG. 3. WASTING SHEET PACKING

It should be remembered that small leaks grow and often develop at inconvenient seasons, and that encourages the tendency to become slovenly in the upkeep of other things, and the better way to eliminate them is to see that a suitable gasket is placed on the joints at the earliest opportunity. Hanging a pail to catch the leakage from a joint, Fig. 2, is a poor makeshift for a properly made flange joint. It costs much more to repair a leaky joint than to provide a suitable gasket in the joint in the first place, thus avoiding the expense of shutting down and the extra work entailed. One leak may not make much difference in the steam lost, but a number of leaks will require considerable extra coal to make up the loss.

Under the old method of purchasing gasket material there was considerable loss from waste, partly through the carelessness of the man who was cutting it from the

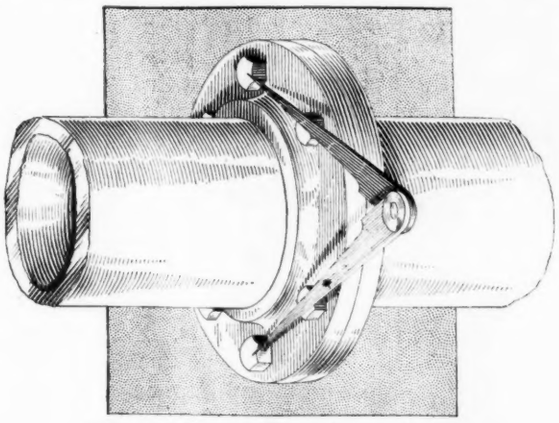


FIG. 4. MEASURING FOR A GASKET

sheet packing. Good packing is expensive, a fact which is ignored by many engineers in cutting it up. When a gasket is required, it is not unusual to see a man cut from a sheet a piece several inches larger than is necessary (Fig. 3), then place it on the bench and use a compass to mark it out. The only reason for doing this first cutting is to reduce the original stock to more convenient size for handling.

It is still common to see an engineer using a full-face gasket, which takes twice as much material as is necessary; there is no gain in strength in using a full-face gasket and it only increases the cost. It is the engineer's business to furnish maximum power at a minimum cost and to do this he must be supported by the management.

In specifications regarding piping furnished for new plants or repair work, not enough attention is given regarding what goes between the flanges. Generally, it is understood that the work has to be guaranteed for one year. In some cases a joint holds tight for this length of time, but afterward trouble with the gasket occurs. In new plants I have seen leaky flange joints after three months' operation. Passing through the plant daily, I watched these joints for ten weeks, and they finally grew so bad one could hear the steam hissing for a distance of 500 ft. Finally, the engineer did the work that should have been cared for in the specifications. He repaired the joints, but it was exactly two days later when the joints leaked again for another three weeks. It was a troublesome job to renew the gaskets, as a scaffold had to be built for the support of the piping.

The power plant is the most important part of the works. It deserves, therefore, the most careful attention in handling by the managers and owners because it is the determining factor in the efficiency of all the operations carried on in the factory.

An engineer may know all about the trouble he has experienced from leaking gaskets, but that is not saying that he knows all about gaskets, or as much as the

manufacturer who has kept pace with modern practice in the steam-power plant and has met its every requirement. There is one remedy for leaky joints, no matter how high the pressure or the temperature. There may be more, but of one I have positive knowledge—to use the gasket that is suitable for the work. The copper type of gasket has given satisfaction, and there are other types such as the copper and asbestos combination. Copper is suitable for gasket work on account of its pliability, and asbestos is suitable because of its high heat-resisting properties. A combination of these two make a gasket that will withstand the demand upon it because the metallic gaskets prevent the asbestos from blowing out. Most of such gaskets fit inside the bolt holes and are easily applied to the joints. Sometimes flanges at the joints will not come parallel and it is then advisable to use a little thicker gasket than usual, or to cover the flange evenly with a suitable cement.

An engineer will save himself time and trouble if he exercises care in purchasing gaskets. For instance, he should state the inside and outside diameters of the gasket required and state whether it is for standard flange joints, extra-heavy flange joints, flange unions, male or female joints, tongued-and-grooved joints. While the plant is running, the engineer can, as illustrated in Fig. 4, obtain the size of any required gaskets of a leaky flange without breaking the joints, as follows: First put the calipers on the center of the bolts opposite each other and then subtract the diameter of one bolt, which gives the outside diameter of the gasket wanted. The inside diameter of the pipe gives the inside diameter of the gasket.

Before putting in a new gasket always clean off the old one. A thin file makes a good scraper to do this work. It should be thoroughly done, as an improperly cleaned flange will generally result in leakage. It is only necessary to remove the bolts from one side of the flange, preferably the upper half; then loosen the lower bolts and the gasket may be dropped into place and the remaining bolts will center and hold it in place while all are tightened. When drawing up a gasket, draw the bolts up gradually on all sides so that the two flanges approach each other as nearly parallel as possible.

Polarity of Direct-Current Generators

By Quentin Graham

There are two facts concerning the polarity of direct-current generators that should be kept in mind and between which a clear distinction should be made in order to avoid confusion. The first is, that with a fixed direction of rotation there is only one proper connection for the shunt field; that is, each lead of the field winding must be connected to a particular terminal of the armature and to that one only, or the generator will be unable to build up its voltage. The second point is, that the polarity of the machine when it builds up its voltage is dependent only upon the magnetic polarity of the field due to the residual flux, assuming the direction of rotation to be fixed.

Reference to Fig. 1 will make these points clear. Assume that rotation is in the direction shown and that the magnetic polarity of the field due to the residual flux is as indicated by the letters *N* and *S*. Further, assume that when the machine is started, voltage is generated, by the conductors cutting the residual flux, in such a direction as to send current through the field winding in the direction of the arrowheads. If with the current flowing in this direction in the field winding there is a flux set up which is in the same direction as the residual flux, then the machine will continue to build up its voltage to the normal value. If, now, the field leads are disconnected and then are attached to the opposite terminals and the machine is started up, the tendency is for current to flow through the field winding in the opposite direction, since the residual flux causes a voltage of the same polarity as before to be generated. This reversed field current sets up a magnetomotive force which is opposed to the residual flux and reduces it to zero, the final result being that there is no voltage at all generated. With the field connected in this manner and with the residual-field polarity reversed at the start, the generator will not build up.

With the field connected as it was originally and with the polarity of the residual field in the opposite direction at the start, it will be seen that the generator will

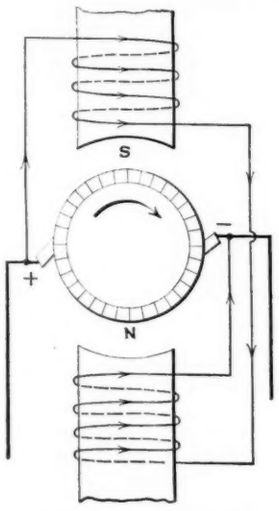


FIG. 1. DIAGRAM OF SHUNT GENERATOR

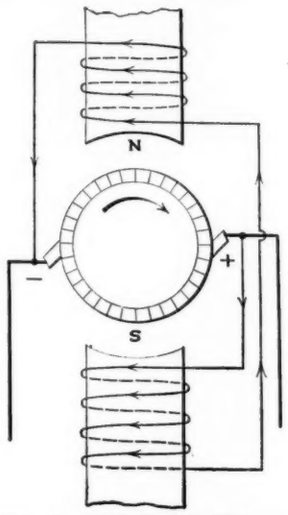


FIG. 2. SAME AS FIG. 1. WITH POLARITY REVERSED

build up its voltage, but that the terminal that was positive before will be negative now, as shown in Fig. 2, which is similar to Fig. 1, but with *N* and *S* interchanged. With this arrangement the voltage generated by the residual flux will be in the opposite direction to that shown in Fig. 1 and will therefore send current through the field winding in the opposite direction. With the field current in this direction the pole at the top of the diagram is excited so as to become a north pole and the pole at the lower part of the diagram becomes a south pole, since with the field current in the opposite direction the reverse was true. Therefore the residual-magnetism polarity of each pole is maintained as it was at the start and the generator will build up its voltage.

To reverse the polarity of a direct-current generator it is necessary to establish the residual flux in the opposite direction. This can be done by separately exciting the field coils for a moment in the proper direction, provided an auxiliary direct-current circuit is available. Furthermore, the polarity cannot be reversed by changing the shunt-field connections.

Improving Plant Conditions

By A. W. BLOM

How changes were made to prevent air from leaking past the end of chain-grate stokers. An interesting type of feed-water heater was also made working on the jet condenser principle.

SEVERAL months ago I took charge of a small heating plant, where the conditions were such that a number of changes were desirable, which, when made, improved the efficiency of the plant about 40 per cent., and the end is not yet.

One of the changes was in connection with the chain-grate stokers on which no adequate provisions had been

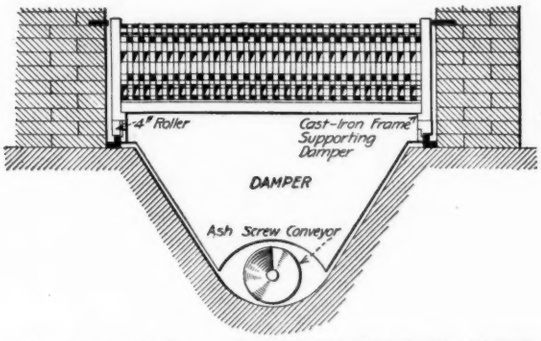


FIG. 1. V-SHAPED ASHPIT AND PRESENT DAMPER

made for preventing cold air from sweeping up behind the grate. Metal dampers had been provided for this purpose, but being nearly square, they did not fit the ash-pits, which were made V-shaped. Furthermore, the

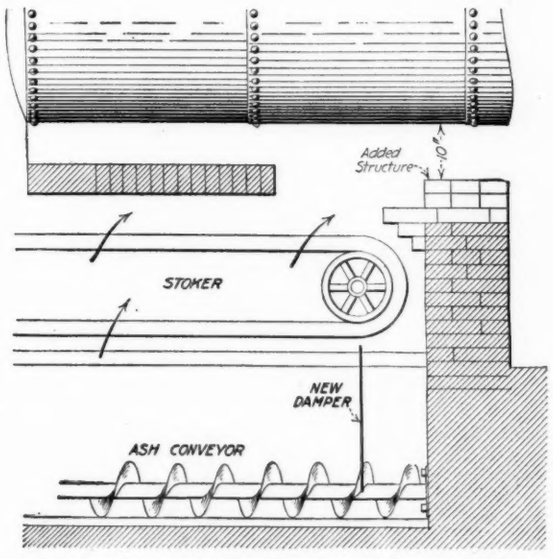


FIG. 2. LIGHT PORTION OF THE BRIDGE-WALL INDICATES ADDED BRICKWORK

dampers were not placed in a position to do much good. We cut them off to conform to the shape of the pits and hung them on 1-in. reinforcing rims cast on the inside edge of the stoker frame. Each damper was placed snug against the last roller on which the grate rides, and about 18 in. from the end. Fig. 1 shows the shape of the ashpits and the position of the damper.

As a result the fires took on a sizzling white color instead of a cherry red. We have also improved the damper regulation in the uptakes, so that they can be placed in any position instead of only wide open or tightly closed, as before. No. 1 boiler had not been used to any extent during its ten years of life, the claim being made that it was "no good," as it would not burn the coal. We rebuilt the bridge-wall and extended it to within 10 in. of the boiler shell, instead of 24 in., as formerly, and extended it toward the grate to close up the air space. We have had one furnace arch rebuilt and lowered to within 12 in. of the grate, in the center, instead of 15 in. as before. These changes, which are

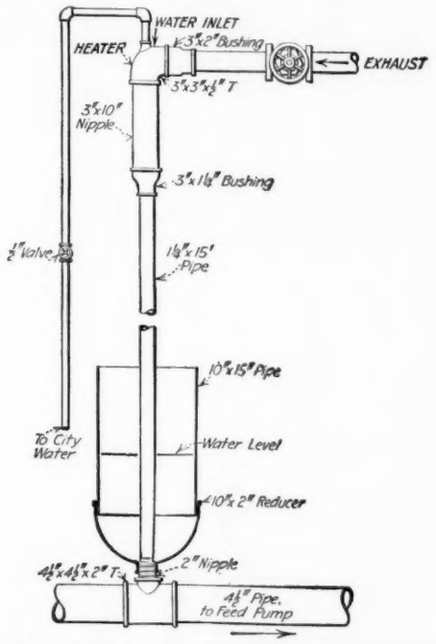


FIG. 3. DETAILS OF THE HOME-MADE HEATER

shown in Fig. 2, greatly improved the combustion of this boiler furnace.

There was no feed-water heater in the plant, it being claimed that none was needed, as the returns would come back hot from the heating system. This was true to some extent during the heating season, but as about 50 per cent. raw water has to be used for makeup, this greatly reduced the temperature of the return, and as no automatic device was provided for controlling this water supply, it would go to the boiler at any temperature between 35 deg. and 180 deg., the higher temperature being obtained from the heating-system returns. To control the steam pressure, the firemen would open the cold-water inlet valve when the steam pressure was high and return to warm-water feed when the pressure was reduced. As we were feeding through the blowoff pipe, this was a dangerous practice, besides being unsatisfactory. That the boilers were not ruined in years gone by was doubtless due to the poor combustion ob-

tained, which had prevented them from being run at anywhere near their rated capacity. As the higher rating was now obtained owing to the improved furnace conditions, the danger became acute.

We had made several unsuccessful attempts to obtain a feed-water heater, but as none was forthcoming, we set about making one of fittings about the plant. It operates on the principle of the siphon condenser and is made about as shown in Fig. 3. The head of the condenser consists of a 3 x 3-in. tee, with a ½-in. opening

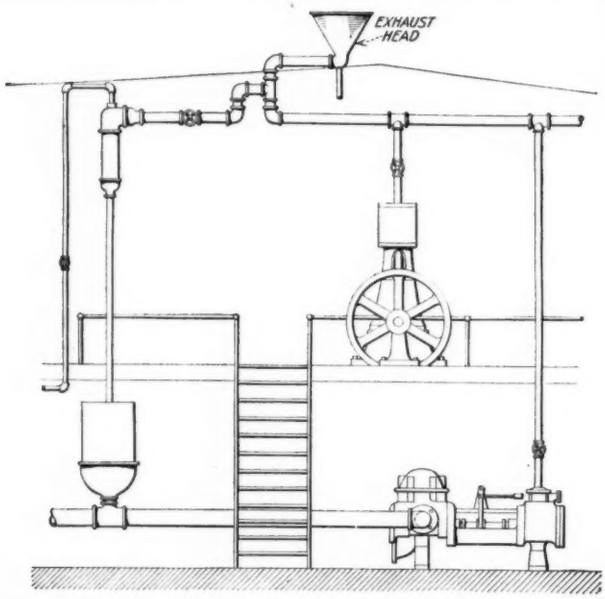


FIG. 4. PIPING OF THE AUXILIARIES TO THE HEATER

at the top. Into this was screwed a 3 x 2-in. reducing bushing for connecting the 2-in. exhaust pipe from the auxiliary. The other end of the tee took a 3-in. nipple 10 in. long, and to this was screwed a 3 x 1¼-in. reducer into which a 1¼-in. pipe 15 ft. long was fitted.

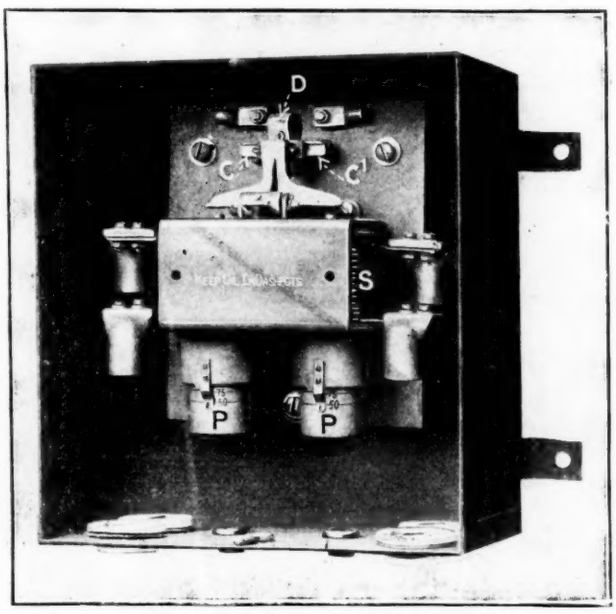
The suction pipe to the feed pump was 4½ in. in diameter and was fitted with a 4½ x 4½ x 2-in. tee. To the side outlet of this tee a short nipple was screwed, to which a 10 x 2-in. reducer was attached. Into the large end of the reducer a 10-in. pipe 15 in. long was secured and opened at the top, and into this the 1¼-in. drop leg from the heater head extended so that the end came a trifle below the top end of the 2-in. nipple that screwed into the tee on the suction pipe. The water inlet was through a ½-in. pipe, which connected with the 3-in. tee at the top of the heater head. The operation of this heater is obvious. The exhaust steam from the auxiliaries enters the head and mingles the water coming in through the ½-in. pipe. The steam is condensed and flows into the 10-in. receiving pipe, from which it is drawn to the pump through the suction. Between the heater and the auxiliary units and exhaust head, an atmospheric back-pressure valve is piped in so that any excess steam not used in the heater can discharge to the atmosphere. The piping of the system is shown in Fig. 4. This heater raises the temperature of the water to about 200 deg., and owing to the changes made, two boilers now do the work formerly done by three.

Before these improvements were made we burned 2450 tons of coal per year and it was expected to reduce this to 1450 tons, or a saving of 1000 tons. This figure was not quite reached due to the extremely cold winter, but a saving of about 700 tons has been made, or a 30 per cent. decrease in coal consumption. Had the winter been a normal one the saving of 1000 tons of coal would doubtless have been accomplished.

"Safety First" Relay

"Safety First" relay, shown in the figure, is designed to provide a safe and efficient method of supplying overload protection for alternating-current apparatus equipped with starters or switches having low-voltage protection, and is manufactured by the Westinghouse Electric and Manufacturing Co. The relay is inclosed in a sheet-steel case, the cover of which is provided with a safety device which automatically trips the relay when the cover is removed, thus rendering all its parts dead as long as the cover remains off, so that inspection or repairs can be made without danger. This safety device is a flat looped spring *D*, which, when free to act, holds the contact bridge away from the contacts *C* and *C*'. When the cover is fastened in place, this spring is depressed by a pin on the cover, thus allowing the contact to be made between contacts and bridge.

The relay operates by means of magnet coils *S*, which, when the current value reaches or exceeds that for which they are set, lift plungers that break the control circuit at *C* and *C*' and operate the low-voltage relay to open the line circuit. With no current flowing in the



RELAY WITH COVER REMOVED

line, the coils are deënergized and the relay is automatically reset. The plungers operate in oil dashpots *P*, providing a time element which allows the relay to carry a momentary overload without tripping. This time limit is adjustable by means of a small perforated disk in the dashpot, which is readily accessible by unscrewing the dashpot from the casting which holds it.

These relays will operate over a wide range of current values, for which adjustments can readily be made by lowering or raising the dashpot, and they are made in all commercial frequencies and voltages and in capacities of 5 to 300 amperes.

The Electrical Study Course—Armature Reaction

What armature reaction is, its effects upon the operation of the machine, and how these effects are neutralized, are discussed.

THE effect of the armature current upon the lines of force from the polepieces is one that has an important influence on the operation of electrical machinery. So far in our studies of the electrical machine we have considered that the flux passes from the N to the S pole, symmetrically distributed over the faces of the pole, as in Fig. 1. This, however, is true only when no current is flowing in the armature, as in the figure.

In Fig. 2 the field poles are not excited, but current is assumed to be supplied to the armature windings from an outside source. This current is flowing through the windings in a direction to produce an N pole on the left and an S pole on the right, causing a magnetic field to be set up in the direction indicated by the dotted lines and arrowheads, at right angle to the lines of force from the polepieces in Fig. 1.

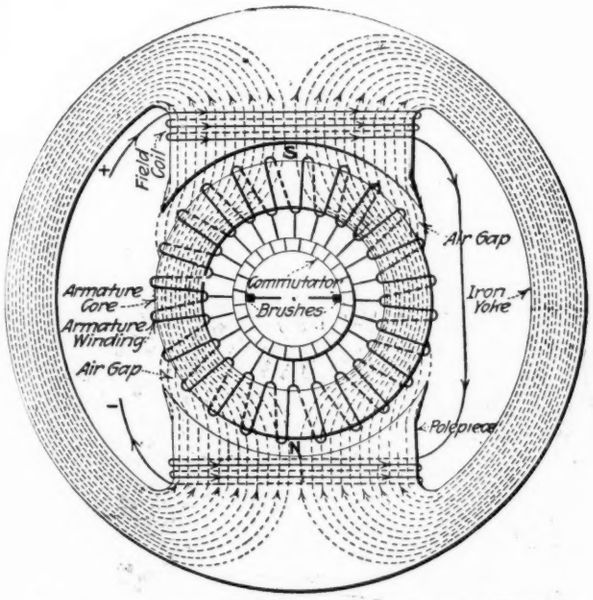


FIG. 1. DISTRIBUTION OF FLUX FROM POLEPIECES WITHOUT CURRENT IN THE ARMATURE

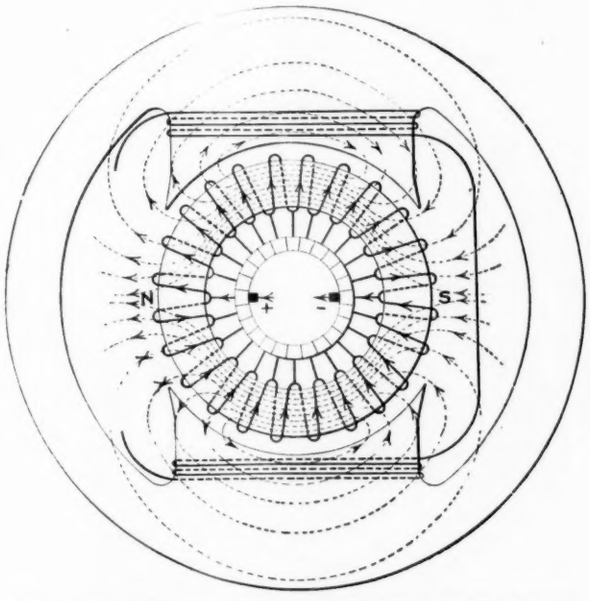
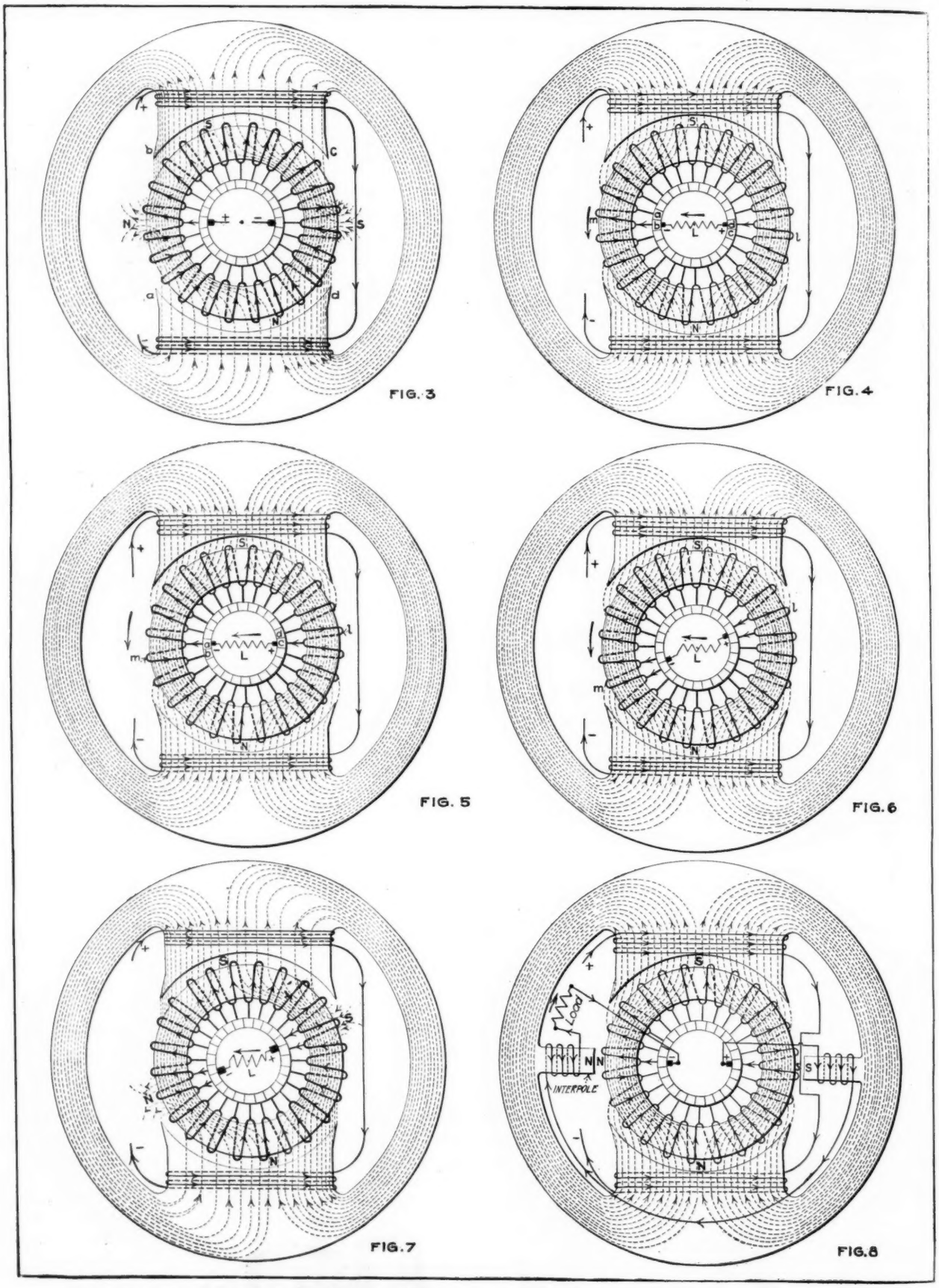


FIG. 2. DISTRIBUTION OF ARMATURE FLUX WHEN FIELD POLES ARE NOT EXCITED

It is evident that if we combine the magnetic fields of Figs. 1 and 2 in one machine, one field will tend to distort the other. This is shown in Fig. 3, where the fields are excited and current is flowing in the armature at the same time. From Fig. 3 it is seen that the N pole of the armature opposes the lines of force from the north-pole tip marked *a*, and assists the south-pole tip marked *b*, where the S pole of the armature opposes the flux from the south-pole tip marked *c* and assists the north-pole tip marked *d*. This causes the flux from the field poles to be pushed to one side, or distorted, as it is generally referred to, decreasing the number of lines of force at pole tips *a* and *c* and making the magnetic field more dense in pole tips *b* and *d*, as indicated in the figure. This effect of the armature's magnetic pole upon the field flux is called armature reaction.

In Fig. 4, if the armature is revolved in the direction of the curved arrow, there will be generated in the armature windings a voltage which will cause a current to flow in the external circuit *L*, as indicated by the arrow. When the armature revolves through an arc equal to the width of one segment, as in Fig. 5, it will be seen that the current has reversed in coils *l* and *m*. It was shown in the lesson on commutation in the Mar. 12 issue that in order to cause the current to reverse in the armature coils under commutation in the short period required for one commutator segment to pass out from under the brush and another move in, it is necessary to induce a voltage in the coils under commutation in a direction to assist in reversing the current. This, it was pointed out, could be obtained by shifting the brushes on a generator in the direction of rotation, as in Fig. 6, so as to bring the coil under commutation in a position into the magnetic field to generate a voltage in it of a direction that will assist in reversing the current in the coil. Comparing the direction of the voltage generated in coil *l* in Fig. 6 with the flow of the current in coil *l*, Figs. 4 and 5, it will be seen to be opposite to that in Fig. 4 and in the same direction as that in Fig. 5, showing that the volts generated in coil *l*, Fig. 6, assist in changing the direction of the current in the coil as it passes the brush.

To obtain sparkless commutation it requires that the current generated in the coil passing under the brush have a voltage generated in it by cutting the lines of force from the pole tips, equal to the volts induced in the coil due to the inductance of the current changing in direction in the coil, which means that the brushes must be shifted to a position so as to bring the coil under commutation in a location under the pole tips



FIGS. 3 TO 8. DISTRIBUTION OF LINES OF FORCE FROM FIELD POLES UNDER DIFFERENT CONDITIONS

where the magnetic field is just dense enough to cause this voltage to be generated.

If it were not for the fact that the inductance in the coil increases as the current increases, and the strength of armature's magnetic poles is also increased, the latter causing the armature's poles to have a greater tendency to push the flux away from the field-pole tips that the armature coil being commutated is under, it might be expected that once the brushes were set the machine would operate satisfactorily at all loads. However, the greater the current supplied by the armature the higher the commutating voltage induced in the coil must be to overcome the effect of inductance due to the current being reversed, which means that the brushes must be shifted to a location so as to bring the coil under commutation into a denser part of the magnetic field from the polepieces. But when the brushes are shifted, this brings the magnetic pole of the armature near the field pole, consequently the former is more effective in distorting the lines of force from the latter, thus aggravating the condition, so that instead of the

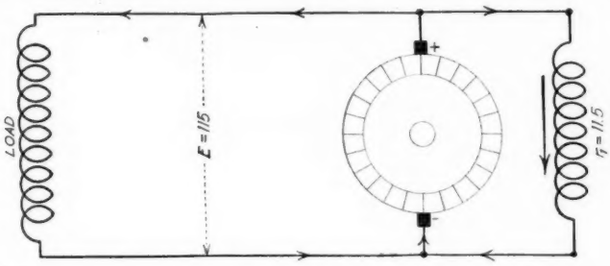


FIG. 9. SHUNT GENERATOR CONNECTED TO LOAD

lines of force being distributed uniformly across the pole faces, as in Fig. 6, they are distorted, as in Fig. 7. Comparing Fig. 3 with Fig. 7 it is evident that when the magnetic poles of the armature have been shifted in the latter, so that they are near to the field poles, they will have a greater effect in distorting the flux from the latter. And as the current increases in the armature, the flux from the field poles is pushed farther away from the brushes, thus necessitating a farther shift in the direction of rotation to keep the coil under commutation in a field strong enough to generate the necessary voltage for commutation.

In the earlier types of machines using copper brushes good commutation depended very largely upon keeping the coil under commutation in a magnetic field where it would generate sufficient voltage to reverse the current in the coil during the period of commutation. This required the brushes to be shifted for every change of load. The introduction of the series winding along with the shunt winding on the polepieces not only improved the voltage regulation of the machine, but also helped to improve commutation, since, as the load increased on the machine, the strength of the magnetic field in the polepieces was increased, which tended to oppose the increased distorting effect of the armature's magnetic pole. The carbon brushes also were a factor in improving commutation; although they had no effect on the electrical or magnetic characteristics of the machine, their high resistance, compared with copper brushes, had a marked tendency to choke down the current in the coil under commutation and prevent sparking. Also, a carbon brush is nonfusing.

Another feature that was incorporated in the design of the machine and that went a long way toward offsetting the effect of armature reaction and improving commutation was the use of thin pole tips, as in the figures, and working them at a high magnetic density. These features, along with a better proportioning and distributing of the iron and copper, made it possible to design the modern machine so that it would give fairly good commutation from no load to full load, with the brushes exactly on the neutral, as in Figs. 4 and 5.

Another method, which has been employed extensively during recent years, to improve commutation, is what is known as an interpole; that is, a small pole between the main poles with a winding on it connected in series with the armature, the same as a series winding, as shown in Fig. 8.

The interpoles are made the same polarity as the armature, and, if made the same strength as the armature poles, will neutralize the latter's effect. Since interpole winding is in series with the armature, its magnetic field will increase in value as the load increases on the machine, the same as the strength of the armature magnetic pole. Consequently, if the interpole is properly proportioned, its magnetomotive force will be practically equal to that of the armature at all loads, therefore will neutralize the effect of armature reaction, and the lines of force from the main pole will be symmetrically distributed, as shown in Fig. 8. The interpole field is generally made of such a strength that it will not only neutralize the effect of armature reaction, but also furnish a flux to generate the commutation voltage.

The problem given in the last lesson is: A given shunt generator, when supplying a constant load, requires 175 hp. to drive it. The voltage at the armature terminals under this condition is 115. The core losses of this machine amount to 4.5 hp. The field-winding resistance is 11.5 ohms, the armature-copper losses amount to 3500 watts, and to overcome the friction of the machine requires 1.5 hp. Find the percentage of efficiency that the machine is operating at.

The input in this case is 175 hp., and the output will be equal to the input minus the losses in the machine. The field current i_1 is equal to the volts divided by the field resistance r_1 or $i_1 = \frac{E}{r_1} = \frac{115}{11.5} = 10$ amperes. The field watts $W_1 = Ei_1 = 115 \times 10 = 1150$. The core losses are 4.5 hp., or $4.5 \times 746 = 3357$ watts; 1.5 hp., or $1.5 \times 746 = 1119$ watts is expended in overcoming the friction on the machine, and the armature-losses are 3500 watts. Then the total watts loss is $1150 + 3357 + 1119 + 3500 = 9126$ watts. The horsepower input is 175, or $175 \times 746 = 130{,}550$ watts.

Output equals the difference between input and the losses in the machine, or in this case 130,550 — 9126 = 121,424 watts.

$$\textit{Per cent. efficiency} = \frac{\textit{output} \times 100}{\textit{input}} = \frac{121{,}424}{130{,}550} = 93 \textit{ per cent.}$$

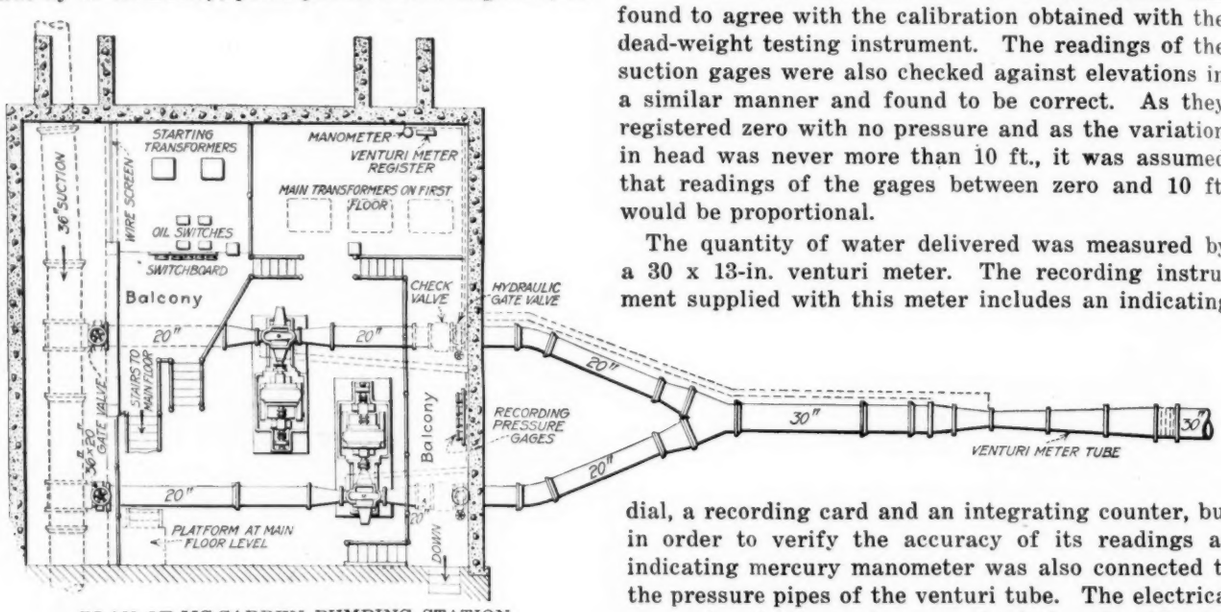
1. At what ampere value should the circuit-breaker be set, or what size fuses be used, to protect a 75-kw. 120-volt machine, if the circuit is to open when the load on the machine reaches 120 per cent. normal value?

2. A generator, when supplying a load of 750 amperes at 130 volts, operates at an efficiency of 89 per cent.; how many horsepower is required to drive it?

Water-Works Pumps with High Efficiencies

Many pumping problems are most conveniently solved by electric-driven units. Such pumps constitute a peculiarly desirable load for central stations, as they operate either at full load continuously, or in some cases only during periods of light load, thus helping to fill up the "valleys" in the load curve.

Where centrifugal pumps are operated by power purchased through a meter, careful attention is likely to be given to efficiency, as a small percentage in efficiency will in a short time amount to more than the cost of the pumps. The figures showing efficiency and other characteristics of two 12-in. motor-driven centrifugal pumps herein given are taken from a report made by J. W. Kelsey, principal assistant engineer, to



PLAN OF MC CARREN PUMPING STATION

G. O. House, general superintendent, of the St. Paul Water Department, and relate to equipment recently installed at the McCarren pumping station.

The specifications required that each unit should be guaranteed to deliver not less than 5000 U. S. gal. per min. against a total head of 171 ft. and not more than 5500 gal. per min. against a total head of 158 ft., the over-all efficiency from "wire to water" to be not less than 72 per cent. when pumping continuously at either of the heads and deliveries. It was further required that when delivering against a reduced head of 140 ft., the motor should not be overloaded.

The bid of the Northwestern Electric Equipment Co., of St. Paul, which was accepted, offered pumps manufactured by the De Laval Steam Turbine Co., and synchronous motors of the rotating field type by the Electric Machinery Co., and guaranteed an efficiency of 74.3 per cent. at heads of either 158 or 171 ft., and an over-all efficiency of 73.7 per cent. at 140 feet.

The motors receive three-phase 60-cycle current at approximately 2200 volts and drive the pumps at 1200 r.p.m. They are so designed that they can be started by the application of alternating current to the armature windings. In normal operation they are supplied with exciting current by direct-connected exciters of $1\frac{3}{4}$-kw. capacity. The pumps are of the single-stage double-suction volute type, having 12-in. suction and discharge nozzles. No diffusing vanes are used.

After installation both units were subjected to very complete tests to determine both efficiency and head-capacity characteristics. Before the official tests were run, the impellers had been turned down slightly in diameter, owing to the fact that the motors were operating at 20 r.p.m. above rated speed.

Before beginning the test, the pressure gage of each pump was taken off and calibrated on a dead-weight testing instrument and then replaced, the pump stopped and the static head of water determined by finding the elevation of the center of the gages and the elevation of the water in the high-service reservoir. The head determined from the elevations was found to agree with the calibration obtained with the dead-weight testing instrument. The readings of the suction gages were also checked against elevations in a similar manner and found to be correct. As they registered zero with no pressure and as the variation in head was never more than 10 ft., it was assumed that readings of the gages between zero and 10 ft. would be proportional.

The quantity of water delivered was measured by a 30 x 13-in. venturi meter. The recording instrument supplied with this meter includes an indicating dial, a recording card and an integrating counter, but in order to verify the accuracy of its readings an indicating mercury manometer was also connected to the pressure pipes of the venturi tube. The electrical measuring instruments were checked and calibrated subsequently by comparison with standard instruments by representatives of the Northern States Power Co.

In running the test, the head against which the pumps worked was controlled by means of a hydraulic gate valve on the discharge side of the pumps. After throttling the gate valve, no readings were taken until all instruments had ceased fluctuating, after which two or three readings were made and averaged, if any variations were found. Observations were made with the pumps operating under four different heads, covering a wide range of delivery.

The results obtained on the official test are shown in the accompanying tabulation. In computing the efficiencies of the pumps alone, motor efficiencies, as obtained on tests of the motors by the University of Minnesota, were used. On motor No. 1 the following efficiencies were obtained: Full load, 95.5 per cent.; three-quarter load, 94.9 per cent.; half load, 93 per cent. Motor No. 2 gave the following results: Full load, 95.3 per cent.; three-quarter load, 94.6 per cent.; half load, 92.5 per cent. The test results of the units show the variations in head and capacity at constant speed, together with electrical horsepower input and over-all efficiencies.

The efficiencies obtained on these pumps are quite high, considering the comparatively small capacity and the high head. Many builders would advocate the use of diffusing vanes for such conditions, which, however, would make the pump more expensive and complicated without any gain in efficiency. The efficiencies are further very high over a considerable range in capacity. Take for instance pump No. 2, which at a capacity of 6527 gal. per min. shows an efficiency of 81.8 per cent., and at 4097 gal. per min. an efficiency of 77 per cent., or for a reduction in capacity of about 37 per cent. there is a reduction in efficiency of only 5.9 per cent., which must be considered very good for a centrifugal pump.

The pumps deliver slightly more than 5500 gal. per min. at 158 ft. total head, but this was not at all objectionable because the efficiency was very high also at low heads, which in this particular case was of great advantage, as can be seen from the following quotation from the official report:

As to the quantity of water pumped, it will be observed that it more than meets the requirements of our specifications. The clause in our specifications limiting the quantity of water to 5500 gal. per min. when working against a head of 158 ft. was inserted to insure a high efficiency at this pressure. It was our belief that the maximum efficiency would be obtained when pumps were working against a much higher head. Fortunately, however, the reverse is true, and our pumps are delivering a greater quantity of water, with a higher efficiency than was anticipated at the lower heads.

As stated before, the friction loss in our force mains is less than computed, with the result that our operating head is somewhat lower than provided in our plans, which explains one of the main reasons for reducing the effective diameter of the impellers. The consequence is a greater quantity of water, at a higher efficiency against our prevailing dynamic heads.

RESULTS OF EFFICIENCY TESTS

	—Motor No. 1—		—Pump No. 1—		Motor No. 2—		—Pump No. 2	
Voltmeter	2,230	2,230	2,240	2,240	2,250	2,260	2,270	2,295
Rec. watt-hr. meter	234	225	210	165	224	217.4	204.8	188.1
A.C. ammeter	62	59.5	55.5	44.5	57.6	56	52.4	47.8
P.F. indicator, per cent	100	100	100	100	100	100	100	100
Ind. wattmeter	233.3	226.2	210.1	165.3	226.3	220.2	206	188.9
Vent. manometer	9.75	8.50	7.25	4.60	9.4	8.24	7.1	5.9
Press. gage, ft.	147.25	165.25	179.25	195.75	146.5	163	176.5	186
Suc. gage, ft. press.	4	6	7.5	10	3.2	5	6.5	8
Total head, ft.	143.25	159.25	171.75	185.75	143.3	158	170	178
R.p.m.	1,220	1,220	1,220	1,220	1,220	1,220	1,220	1,220
Gal. per min.	6,771	5,900	5,035	3,194	6,527	5,722	4,930	4,097
Water hp.	245.1	237.5	218.4	150	236.4	228.7	211.9	184.3
Electrical hp.	312.9	303.3	282	221.7	303.4	295.2	276.1	253.1
Over-all efficiency	78.4	78.3	77.7	67.7	78	77.5	76.4	72.8
B. hp.	298.5	289.6	269	209.9	289	280.8	262.2	239.3
Pump efficiency	82.2	82.1	81.2	71.5	81.8	81.5	80.7	77

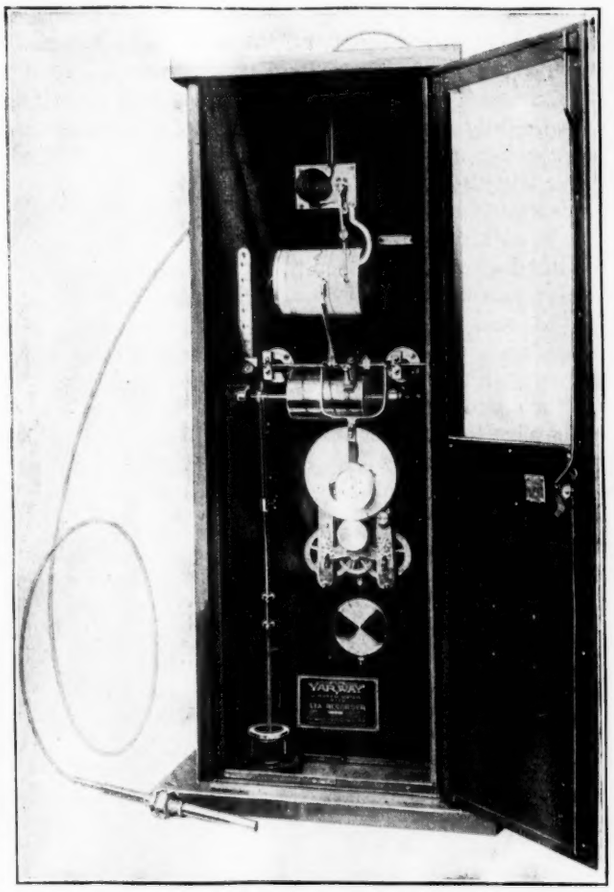
Water Power in the State of Washington

Of the Government estimated 27 million potential water horsepower in the United States, Washington claims about 5 million within her borders. Oregon ranks next with approximately 3½ million, so that these two states have nearly one-third of all the water power available. The natural causes are the heavy precipitation, the rapid fall in the streams and the extensive area drained by one of the largest rivers on the Continent and its tributaries. Of all this vast potential power in the State of Washington only slightly over 300,000 horsepower is at present developed.

The cost of electricity to the consumer it is said, by W. E. Herring in a book issued by the State Department of Washington, is less in Washington than in any other part of the United States. Electric companies are selling current to coal mines and lumber mills for their entire operation in competition with cheap coal from the mines and lumber refuse from the mills where the only way of getting rid of the refuse is by burning it.

Improved Yarway V-Notch Meter

The accompanying illustration depicts the latest development in the construction of the Lea, now known as Yarway V-Notch Meter, and as shown, the meter can be equipped with a temperature recorder that will prepare a record of a feed-water temperature at the same time and on the same chart on which the weight of feed water is recorded. In this way the temperature of the feed water may be ascertained and recorded for future reference at any time during the 24 hours and in exact relation to any change in the character of the feed. It is also an obvious convenience that the temperature record can be filed in the book that is furnished with the meter, thus making reference to both meter and temperature records very easy. The outfit is furnished complete with a 5-in. sensitive bulb, a separate ¾-in. connection and 10 ft. of flexible insulated tubing.



YARWAY V-NOTCH METER AND TEMPERATURE RECORDER

The Yarway V-Notch Meter with the Lea Recorder is manufactured by the Yarnall-Waring Co., Chestnut Hill, Philadelphia, Penn.

There are now four times as many vessels in the United States Naval Service as a year ago.

Guarding the Quality of Coal

By E. L. COLE
Secretary of the Conservation Division of the Federal Fuel Administration for Pennsylvania

The following address before the spring meeting of the American Society of Mechanical Engineers at Worcester is quite conclusive evidence that the Administration is carefully guarding the quality of coal used in power plants and homes.

I BRING you a message of optimism. The statement that the Fuel Administration has encouraged the production of coal in wagon mines should be corrected. Only yesterday I traveled 340 miles to prevent the opening of some wagon mines because of the inferior quality of the coal produced. In addition to that, the Pennsylvania Fuel Administration condemned at Scranton last Friday 39 of the cars of coal. It closed up the Cambridge colliery at Shenandoah and told the operators that they would have to put in equipment to the value of $15,000 before they could resume operation. Just before I came to this meeting, the Administration sent a telegram to the Shamokin Washery Co., at Mt. Carmel, Penn., that they would have to rebuild their plant entirely before they could ship another pound of coal. Last Tuesday the Administration diverted en route to Philadelphia five cars of coal because it contained 37 per cent. slate. That is the work that the Administration is doing.

The estimates that 5 per cent. of the coal shipped to New England last winter was slate is entirely too conservative. Along the New England coast the coal delivered contained from 40 to 55 per cent. of this impurity. During January more than half of the coal delivered contained 40 per cent. of slate. The Administration formulated a standard of impurities that should not be exceeded. The operators thought it was a joke, and not until inspectors were appointed did they realize that the Government would not permit delivery of inferior fuel. Coal that was delivered in Philadelphia was sent back to the mines. Seven cars were hauled to the dumping ground; three cars in one day were given to a church, 18 cars to a hospital, and the operators compelled to pay the freight demurrage charges and cartage bill. In addition to that the name of every operator was published. The name of the jobber was published.

On Monday the president of one of the largest anthracite-producing companies, Mr. Hubert, of the Lehigh-Wilkes-Barre Co., had the audacity to ask the Fuel Administration of Pennsylvania to allow the amount of impurities delivered in anthracite coal to be extended 2 per cent. This would be equivalent to dumping on the market 1,600,000 tons of slate and dirt, naturally at an additional profit of $6,000,000 to the operators. It is seen, therefore, how essential it is that the Fuel Administration have your hearty coöperation.

Only yesterday we received a check for $340 from the Dexter & Carpenter Co., of Philadelphia—I mention the name of the company so you will know that I am giving you a bona fide case—for delivering inferior coal. Only yesterday we had the pleasure of sending a check from the Philadelphia & Reading Coal Mining Co. to the Columbia Mills in Philadelphia. Four weeks ago we threatened the Delaware & Hudson, which supplies this territory with coal, with prosecution unless it stopped putting 55 per cent. of pea coal into its chestnut.

On behalf of William Potter, the Federal Fuel Administrator of Pennsylvania, we say he pledges himself and his administration to aid any measure undertaken by this society or any other organization to provide consumers, industrial and domestic, with reasonably clean coal. Because the anthracite production is confined to Pennsylvania, the responsibility for overseeing the quality of production rests largely on the shoulders of Mr. Potter. It is his part to see that the vast tonnage reaching almost to 80,000,000 tons, from the Pennsylvania mines, that goes into the millions of homes throughout the country, shall be of a quality that will enable manufacturers to produce the essential commodities of life with a minimum coal consumption and cost.

The consumer of coal who accepts coal which is inferior has himself to blame for the inferior results.

[The photograph shows a pile of slate and rock received with coal and sold as such in Connecticut. Note the two 2-ft. rules on the pile.—Editor.]

EDITORIALS

Determined To Give Good Coal

THIS period of industrial and social adjustment through which the country is passing comes hard to most of us; but there are those to whom the swiftness of changing events is bitter. There are those who are so shackled in the tentacles of customs and procedure of the past that abrasion of mind and laceration of soul come with each new day. They transgress and are astonished to learn that the way of the transgressor is hard. They defy and are taught that defiance is not only unavailing but punishable. There is, on the whole, nothing malicious or intentionally unpatriotic in this resistance. Most of those who guide the destinies of industries have shown that they are glad to go the limit in making their particular spheres of activity of greatest national force in this colossal task of winning the war. They have given all that they have and all that they are.

Among those who, because of the suddenness of the emergency and the enormous magnitude of their industry, have chafed under the ever-tightening grip of the Fuel Administration, are the coal operators. But they are making progress. The Fuel Administration shows a determination to give the public good coal that rather surprises the "let-us-alone" contingent among coal men. The address by Mr. Cole, of the Federal Fuel Administration for Pennsylvania, which appears on the opposite page, is good news to users of coal. With a more severe coal shortage facing us this winter than confronted us last, after experience with impurities in coal reaching perhaps higher than fifty-five per cent., after burdening already inadequate transportation facilities with rock and slate sold as coal, it is high time that drastic action was taken to cut down the quantity of impurities to amounts which shall not exceed a pre-war average.

A continuation of the measures against offenders such as Mr. Cole has enumerated will do untold good. The power-plant men of the country congratulate the Federal Fuel Administration of Pennsylvania.

But there is another thought that goes with Mr. Cole's address; namely, that the Fuel Administration will just as vigorously guard against the inefficient use of coal as it guards against poor quality.

Municipal Lighting Plants

PUBLIC ownership of electric-light plants is a question that will not down. Dissatisfaction with the high rates and the service given municipal street lighting and to the public in general, in many instances, is resulting in the turning from private to public ownership where it is possible to do so.

Municipal-lighting movements are being agitated in various cities at this time. For instance, at Atlanta, Georgia, there is a proposition to extend the incinerator plant and thus produce enough additional energy with which to operate the city's lighting plant. It seems that the contract with the Georgia Railway and Power Company expired last April, and the city electrician advised against making a new one at the rate asked by the power company, which would increase the city's lighting bill thirty thousand dollars a year. He claims that the company's equipment and system are obsolete and should be made modern. Furthermore, he believes that the condition of the street lamps is such that the major portion of them should be junked. Further, he is of the opinion that the rate for lighting as made in the proposed city contract with the electric company is preposterous, and he recommends that the city does not enter into any street-lighting contract at this time.

Another city that is having its troubles with proposed increased rates for lighting is Monmouth, Illinois. According to Mayor Hanley, the time is coming when that city must act regarding the ownership of the lighting plants for street service. The reason for this is that the former Public Service Company has made the city a proposition regarding street lighting for the next fiscal year that would mean an additional cost to the city of twenty-five per cent. over former rates for an all-night service.

Trouble has also developed at Lynbrook, Long Island, and several surrounding towns, due to the proposed increase in rates for gas and electricity by the Queensborough Gas and Electric Company, which has a monopoly in these villages. The matter has gone so far that resolutions have been adopted protesting to the Public Service Commission, in which it is stated that the proposed rates would make the use of the commodities prohibitive to many consumers. As in other cases, the sentiment seems to be in favor of a municipal ownership of water, electricity and gas plants if relief is to be expected.

The policy carried out by some companies seems to be that, whereas they have been able to secure an increase in rates without much trouble, in the first place, it would be to advantage to try a second time, and that is what is taking place with the Kansas City Light and Power Company, which is asking for another increase in rates. The State Public Service Commission authorized an increase about a year ago when the rates were fixed to permit earnings of six and one-half per cent. on the company's property valuation. Naturally, a protest is being made against the proposed second increase. It is such instances as these that drive small municipalities into building and operating their own lighting plants.

Many towns and small cities are using electrical energy, although they have no existing contracts with the power companies, and with such arrangements trouble is likely to ensue, and that is what has happened at Paris, Kentucky, where there is war to a finish between the city and the Paris Gas and Electric Company. Here is a case where the company is operating without a contract with the city, the current used being charged for at the price that prevailed under the old contract,

which expired January 1 of this year. The company sought to renew the contract at a considerable advance in price, but this was refused by the city. Matters have reached such a state that an ultimatum has been presented by the company, to the effect that unless bills for the last three months were paid at once the current furnished by the city would be discontinued. To cap the climax the wires connecting with some of the city works and the City Hall were disconnected, which action threw out of commission the fire-alarm and the police-call systems. It is understood that it is possible that out of the controversy there may be built a municipal electric-lighting plant.

No one will deny that the cost of operating electric-light plants has advanced since the beginning of the European War, and as a matter of fact so has everything else. The trouble seems to be that lighting companies are endeavoring to obtain rates that will permit them to make the same profit under war conditions that they were previously making. Although this would immensely please the stockholders and operating officials, it is something that cannot justly be expected, and such lighting companies should make up their minds that they will have to bear a reduction in income and profit, the same as numerous other manufacturers and thousands upon thousands of wage earners have had to do and will have to do.

It is true that manufacturers who are engaged in munition work are making excessive profits over pre-war conditions, but that is something to be expected because it is necessary to pay a higher wage in order to get sufficient mechanics and other workmen to supply the demand for their output. A very small percentage of the population of the United States is engaged in munition works, however, and in the majority of cases those engaged on nonwar material are not saving as much money today as they were previous to the war. This is because the cost of food, clothing and other necessities has increased to such an extent that the purchasing power of a dollar is far below what it was.

If the majority of the working population of the United States must live on less income than formerly, owing to the higher prices of necessities, it would seem that electric-lighting companies should be content to do likewise and not strive with all the energy they possess to obtain rates that will enable them to maintain their dividends at a pre-war rate.

The question might be asked as to why it is possible for one electric plant to operate at a profit while others find it necessary to increase their rates in order to make a profit, some of them going to the extent of maintaining that in case increases are not permitted there is danger of the plants going into bankruptcy. The following figures relative to a small plant at Walkerville, Michigan, which is a civic light and power plant the profits of which jumped about one hundred per cent. during last year, are significant. For instance, the net profit for last year amounted to $10,386. The earnings during 1917 totaled $152,162, as against $112,465 in the previous year. The expenditures last year were $135,433, as compared with $102,858 in 1916. We are not familiar with the rates charged in this case, but it is safe to assume that they are not higher than those charged by the average central-station company.

It would seem that if in one instance a power plant can be made to increase its profit one hundred per cent. during war times, there is something wrong when other plants are straining every nerve they possess to influence public-service commissions to permit of an increase in rates in order that they may hold up their heads above water or sink. It looks as though something was wrong.

Secretary Daniels Pleads for Fuel Economy

REGARDING the fuel situation, Secretary Daniels of the Navy says: "Next to man power there is no more important question today than the fuel supply, the use of which is steadily increasing, and it is of paramount importance that our best energy and every reasonable precaution be employed to not only maintain the daily supply of coal for navy use, necessity of which is steadily increasing, but also that in every consistent manner reserve stock be built up at all principal supply yards and delivering points through the summer months and the early fall to protect against the physical difficulties that will later arise through climatic and other troubles.

"The expected consumption for the ensuing fiscal year, by the Navy, of coal for direct use is from three to four times greater than that of the year just ending. It will be apparent that the supply and the transportation facilities, for the reasons set forth, cannot of necessity have developed accordingly."

As the industrial consumption of coal will increase something like eighteen per cent. over last year's consumption, and as the railroads will use about fifteen per cent. more during this fiscal year than they did last, and with the Navy's consumption increasing three hundred to four hundred per cent. as set forth by Secretary Daniels, and, further, as the anthracite production will not begin to meet the needs and as the deficiency must be made up by using bituminous coal, it is evident that power plants will be called upon to exert a supreme effort to make every pound of coal go as far as skill and ingenuity and constant vigilance can make it go. The time has come when the Fuel Administration finds it imperative to give coal only to those who use it economically. That this plan will be carried through we feel certain. We have talked with different officials of the Fuel Administration, and each positively asserts that the Administration is determined to go to the limit that the saving of fuel may benefit the cause for which America is fighting.

The Milwaukee Jovian League Chapter No. 14 has done a commendable thing in getting out an Electrical Directory of Milwaukee, containing not only a list of its members, but a complete directory of the electrical firms of the city, and the surprising and laudable feature of it is that the league did it at its own expense, and without levying tribute upon the firms mentioned in the way of advertising.

The new B wning guns are coming out rapidly; enough for four and a half divisions have been made, and half of these are on their way to Europe. Verily, the Yanks are coming.

CORRESPONDENCE

A Faithful Servant

Editorials of the kind are so rare in our newspapers that the one quoted, from the Brookings, S. D., *Register*, seems worthy of being reprinted. It is refreshing to know that at least one engineer's work is being appreciated.

Sometimes it is necessary for a man to die or move out of a town before his value to the community is recognized. A few kind words to the living are worth more than eulogies over the dead. This is just a preface to calling the attention of the people of Brookings to the fact that in the person of Nels Larsen, engineer at the power plant, we have a man who for nearly fifteen years has been giving the city the maximum of service for a whole lot less than the maximum of pay. During these years he has been doing this faithful service without making any particular noise about it, or calling attention to himself. It has just been a case of quiet and effective attention to duty. We certainly wish him health and long life to stay on the job.

New York City. W. F. SCHAPHORST.

Drying Out Electric Motors

I was interested in the letter, "Drying Out Electric Motors," by G. E. Michael, in your correspondence column of Apr. 30.

It occurs to me that under some circumstances it might be possible to avoid the necessity of heating the compressed air used in drying out the electric motors. Instead of compressing the air to some high pressure, necessitating the use of reducing valves with the attendant trouble of cooling the air as it is compressed and then heating it as it is reëxpanded, it would have been much simpler to compress the air to a pressure at which it was to be used. If in the latter case the air had not been cooled during or after compression, the temperature resulting from compression would probably have been ample for the purpose of drying out the electric motors. The whole process would then have been more economical and efficient.

EMILE J. FERMIER,
Professor of Mechanical Engineering,
Agricultural and Mechanical College of Texas.
College Station, Texas.

Fastening a Loose Crank

There have been published in *Power* recently several methods of fastening engine cranks to the crankshaft. On page 264 of the Feb. 19 issue there was an illustration showing how it could be done by means of three pins, and in the May 7 issue, page 669, another method is shown with a statement that it is better than the one previously given.

My way of doing the job would be to drill a hole in the center of the shaft, drive in a smooth pin slightly tapered so as to expand the shaft symmetrically and then cut off the protruding end.

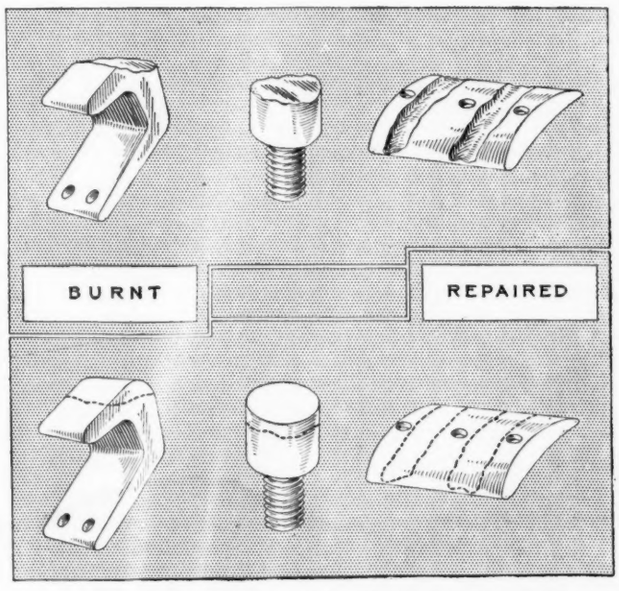
Another little kink, extremely useful on occasion, is that to prevent end slipping, as for instance the thrust coupling of a propeller shaft. This is done by drilling and tapping a hole half in the shaft and half in the coupling longitudinally and screwing in a threaded pin tightly. The pin will then be half in the shaft and half in the coupling. I have used this kink on an engine piston which was $\frac{1}{32}$-in. loose, although it was originally pressed on tight and merely riveted over. The piston was 8 in. in diameter, and the steam pressure was 240 lb. The engine ran at 400 revolutions. I used in this case three $\frac{1}{4}$-in. pins screwed in $\frac{1}{2}$ in., and the job held for two years, when the engine was removed for other reasons.

Another kink that may be useful is one to hold broken crankpins, particularly on double-crank engines. This is to drill lengthwise through the pin and put through a tight-fitting bolt about one-third the diameter of the crankpin, tightening up on the nut so as to hold the original broken edges together. I have known this to be done on large engines, and I have used it on small ones. In these cases the job held nicely and saved the necessity of a new crank in each instance.

Syracuse, N. Y. FRANK R. WILLIAMS.

Repairs by Oxyacetylene Torch

Mr. Cranford's article in the issue of May 28, page 778, on oxyacetylene repair work reminded me of a way I saved about fifty pounds of copper and brass starting-box contacts that otherwise would have been sold as scrap metal. I used the torch to build up the burnt surfaces with copper and then finished them on an abrasive wheel. We use several makes of starting boxes and seldom have to order new contacts, as we repair them several times before discarding.



BURNED STARTING-BOX CONTACTS RENEWED

Braemar, Tenn. J. W. STANLEY.

Leak in Exhaust Piping

We had a great deal of trouble recently with one of our 30 x 48-in. Corliss engines which puzzled us for a long while, the story of which may be of interest. This engine is of the bushed, or sleeve, cylinder type; that is, the working barrel or cylinder proper consists of a cast-iron bushing or tube, 3 in. thick pressed into the outer casting, the space surrounding the bushing forming a steam jacket, as shown in the cross-sectional view, Fig. 1. The exhaust passes from the exhaust ports down through the hollow pedestals of the cylinder into a special fitting.

Some time ago the vacuum, which had been holding steadily at about 28.5 in., dropped to 26 and gradually got down to 22. The condenser, which is of the barometric type, was overhauled, the screens cleaned off, the atmospheric valve reseated and the pump that supplies water to the condenser overhauled, with the resulting gain of two inches of vacuum. Every flange joint was inspected and tightened or repacked without bettering conditions, and it was even suggested that air was entering the boilers by way of leaks in feed-pump suctions and was being carried over with the steam, causing the trouble; but investigation proved this theory to be wrong. To make the problem still more perplexing, it was noticed upon starting up in the morning, that when the injection water was turned on the vacuum would run up to 26 or 27 in. and then gradually drop back to 22 and hold there.

The water used is heavily contaminated with sewage or, to state it the other way around, the sewage we use contains some water. It was suggested that the gases given off by the injection water under vacuum were responsible for the low vacuum, but a test with clean water produced no better results. One morning the steam jacket was cut out to make repairs to the trap, and to my surprise the vacuum gage registered 27 in. A series of tests showed that with the steam jacket on, the vacuum would drop five or more inches quickly, and cutting out the jacket resulted in the vacuum increasing again slowly; so we concluded that live steam from the jacket must be getting into the exhaust in some manner, but opening the exhaust passages and turning the steam on the jacket failed to show any such trouble. There is a 1-in. bleeder connection *A* leading from the steam supply directly to the exhaust passage. Shutting the steam off the jacket until the vacuum was 27 in., I opened this bleeder, allowing all the steam that the 1-in. pipe could carry to pass directly into the exhaust, but the vacuum dropped only half an inch. Here was more steam than the jacket was using, passing directly into the exhaust without causing any considerable loss of vacuum, proving conclusively that the trouble was not leakage of steam from the jacket to the exhaust. We thereupon "stood up on our hind legs, and swore that we would find that leak or bust"; and we did—not, but the boss pipefitter was called in and told that there must be a leak in the exhaust line and that it was up to him to find and repair it. He took down the 15-in. exhaust line and made it up again, but the leak was still there. He crawled under the cylinder, over the exhaust passage and, failing to find any leaks, asked me to turn on the jacket steam, and in a few minutes he called out that he could hear air leaking in. As the heat of the jacket increased, it became too hot for comfort under the cylinder, and in turning around to get out he placed his hand on the exhaust passage at *B* and the hissing sound ceased. Close investigation disclosed a crack in the casting at that point and another developing at the opposite end at *C*.

For convenience, all previous tests for leaks had been made with the jacket steam off, and it was therefore reasoned out that the expansion of the cylinder casting with the steam jacket on had caused this exhaust fitting to crack and, with the jacket steam off, the cylinder contracted and closed up the cracks, making a better vacuum possible. It was suggested that a long bolt be put through the exhaust passage as indicated by the dotted lines, but it was decided that it would only be a makeshift and might cause worse trouble later, so a new connection was designed as shown in Fig. 2. Instead of being cast in one piece, it was made in four sections, the one marked *D*, being a copper expansion joint. We had a little difficulty with the first expansion joint, as there was a flaw in the copper, but the new one is holding all right. I plead guilty to having been somewhat dense in getting at the bottom of this trouble, but the circumstances were misleading.

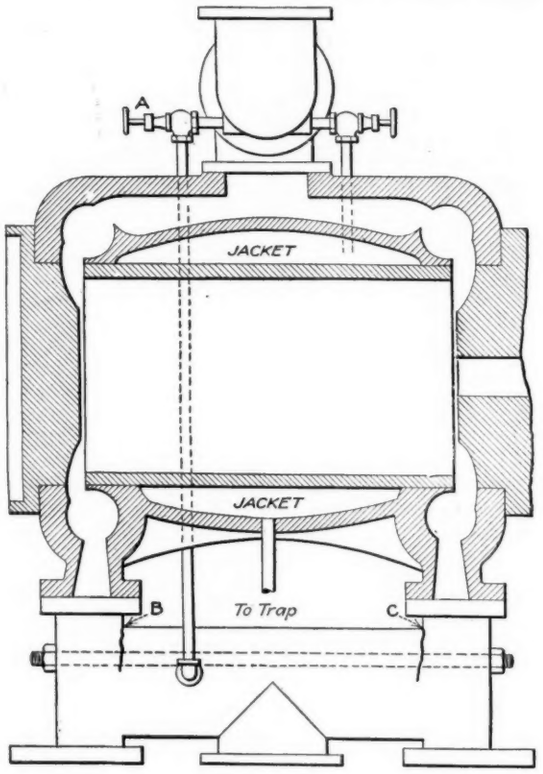


FIG. 1

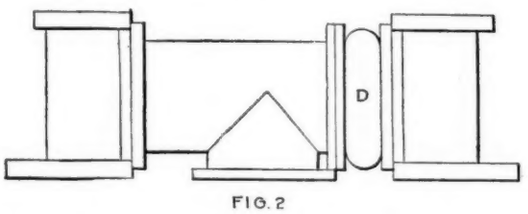


FIG. 2

FIGS. 1 AND 2. OLD AND NEW EXHAUST FITTINGS

Passaic, N. J. C. W. OAKLEY.

Signal Device for Overloaded Cranes

We often hear of accidents due to the breaking of some supporting part of cranes, caused in most cases by overloading, but the real significance of overloading will not be driven home until someone is injured or killed and a lawsuit for damage is settled. The ideas shown

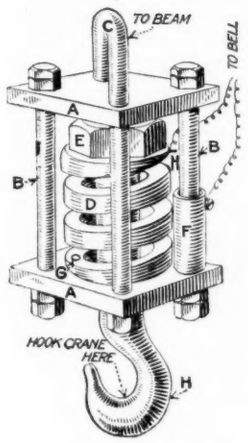


FIG. 1. SINGLE-SPRING CONTACTOR

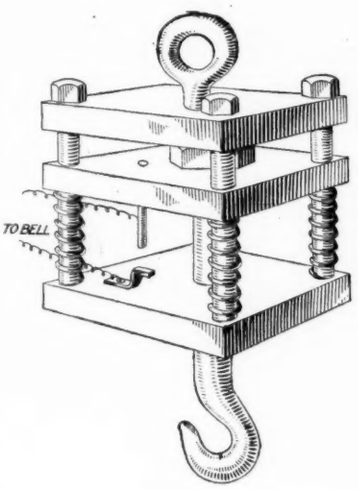


FIG. 2. FOUR-SPRING CONTACTOR

in Figs. 1 and 2 will, if adopted, give warning when a crane is overloaded.

The electric-current principle is used. Two plates *A*, Fig. 1, are held apart by two rods *B* and the bent yoke rod *C*. The hook *H* has a long shank over which passes the supporting spring *D*. This spring works between the bottom plate *A* and the nut *E*, which is screwed and locked at the top end of the shank. The spring, which is fastened at *G* to keep it from revolving, is provided on the upper coil with the feather contact *H*, the spring having been previously tested to determine the distance it will compress when the required limit weight is applied. When this is determined, the distance between the contact *H* and the top of the contact sleeve *F* is made equal to it. As soon as the limit weight is reached, the contact *H* will make connections with the sleeve *F*, thereby ringing a bell or buzzer.

Fig. 2 embodies a slightly different construction, involving the same principles. It allows the use of four light springs instead of a heavy one, thus distributing the support of the weights more equally.

New York City. J. A. LUCAS.

Bearing Oil Caused Commutator Insulation To Fail

A little oil applied occasionally to a commutator that needs it contributes to the development of the much-desired polished wearing surface; it is preferable, however, that such lubrication be obtained by means of self-lubricating brushes. Too much oil on the commutator is a great deal worse than none at all because the excess tends to disintegrate the mica insulation. Oil on the inside of a commutator impairs the effectiveness of the insulation, and its presence is certain eventually to cause a ground to the metal shell; especially is this likely to happen to machines that are operated with one side of the system grounded. Oil in the micas between the bars will cause them to give up their binder, and in time the commutator will develop black spots at irregular space intervals.

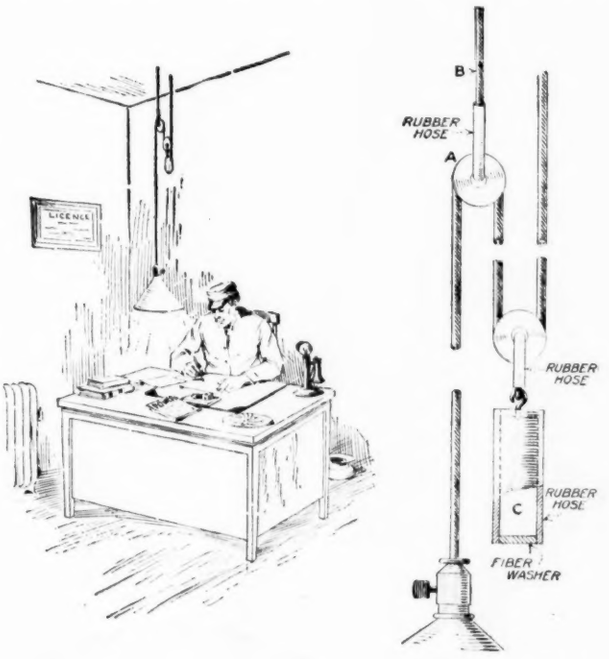
The commutator of a large direct-current generator began to develop black, roughened areas. The armature equalizers were tested and the connections checked, and while everything apparently was all right, all connections were resoldered in order to make sure that no poor contacts existed. The commutator bolts were tightened and the spacing of the brushes checked, also different kinds of brushes were tried, but all to no avail.

Finally the mica between the commutator bars began to fail, leaving holes between the latter. A new commutator was then installed and the old one opened up, which disclosed that its interior was oil-soaked. Investigation developed that all the trouble was due to oil vapor being thrown from the adjacent engine bearing. The installing of suitable barriers stopped the trouble. E. C. PARHAM.

Brooklyn, N. Y.

Adjustable Ceiling Lamp

Lamps over desks and benches can be made adjustable as shown in the accompanying illustration. An insulator *A* is supported from the ceiling by a rubber-covered wire *B*. The counterbalance is made from an



ADJUSTABLE CEILING LAMP IN USE AND DETAILS OF ITS CONSTRUCTION

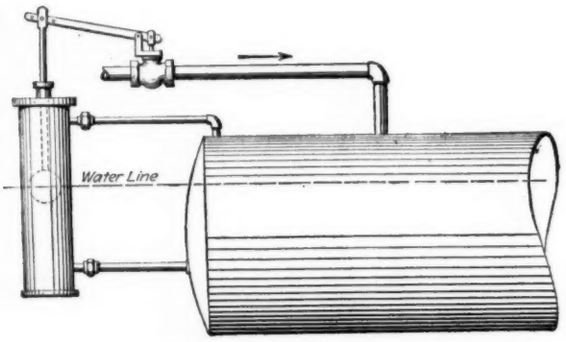
insulator similar to that used to suspend the lamp from, from which a weight *C*, also covered with rubber hose, is hung. The weight should be approximately equal to that of the lamp and reflector. The friction of the two insulators on the rubber will be sufficient to hold the lamp in any desired position. M. P. BERTRANDE.

Ozone Park, N. Y.

Promiscuous Power-Plant Pointers

As a member of the *Power* family for nearly thirty years I have received many valuable ideas and information from it, but my memory has not the storage capacity to retain them all. For instance, the other day my son came to me and said: "Father, I found a dandy old copy of *Power*. It tells how to bend a small-sized pipe by filling it with melted rosin and then letting it cool, after which the pipe can be bent to the desired shape, then heated slowly and the rosin drained out." "Well," I said, "that is a good kink and I have tried it, like the one we learned a short time ago through *Power*—how to vulcanize a rubber hose over a piece of pipe by heating the pipe in a fire, then putting it into the hose and quickly dipping into a bucket of cold water."

I have another, similar but original, idea for facing hard-rubber pump valves by heating a piece of cast iron, having a smooth surface, to a dark red then rubbing the valve on the smooth surface. But perhaps pump valves will soon be out of date and centrifugal pumps



FLOAT TO CONTROL MAKEUP WATER

take the place of piston or plunger pumps. I have recently installed a six-stage centrifugal boiler-feed pump rated at 120 gal. per min. against a head of 420 ft., direct-connected to a 25-hp. induction motor operating at 1750 r.p.m. The pump is guaranteed to give 50 per cent. efficiency. The boilers are equipped with feed-water regulators, which make it an ideal system, but it took me some time to decide to buy it. I followed up every article I could find relative to centrifugal pumps before I came to a decision.

As a rule exhaust steam from boiler-feed pumps is used for heating the feed water, but in this case I will state—what may seem ridiculous—that it does not pay to heat the feed water because we are operating an electric-light, power and central-heating plant where the electric load is not in proportion to the heating load even for a city with 7000 inhabitants. We have an electric output of 7500 kw.-hr. per day, but the steam for heating, as metered by condensation meters, runs about 500,000 lb. per 24 hours as an average during winter months, hence we have to send considerable live steam into the heating mains, and as the condensation is returned to the station by a vacuum pump at about 150 deg. F., I figure it that there is more profit in selling the steam than using it to heat the feed water, even if all the steam delivered to the heating system passed through a feed-water heater.

Suppose we say it would heat the feed water to 210 deg., which is the boiling point for this altitude, there would be a saving of 5 per cent. in fuel as the feed water would have absorbed 30,000,000 heat units from the steam in passing through the heater. Then with coal containing about 6650 B.t.u. per lb. and a boiler and furnace efficiency of 75 per cent., 5000 heat units are absorbed by the water in the boiler per pound of coal fired; then 30,000,000 ÷ 5000 = 6000 lb. (3 tons) of coal would be saved per 24 hours. Price per ton, $2.50, times 3 equals $7.50 saved. But steam is sold at 50c. per 1000 lb., or say 50c. per million heat units, hence the 30 million heat units lost in heating the feed water would be sold and bring a revenue of $15 in place of saving $7.50. This may be an exceptional case, but there may be others that have not given this matter any consideration, like our Fuel Administrator who cut out our sign lights in order to save fuel; but we used practically the same amount of fuel for heating purposes on account of using all the exhaust for that purpose.

This reminds me of an article that appeared in a local paper during our legislative session last winter and that should really come under the heading, "Just for Fun." One of our representatives made a motion to the effect that the two miles of street-car line in Bismarck, owned by the state and operated from the Capitol buildings power house, should be operated from the State Penitentiary plant located near Bismarck, because coal can be delivered at the penitentiary for 50c. per ton less than at the Capitol. In doing so, he said, there would be a saving of 90 per cent. because in order to operate the street cars it required a boiler pressure of 100 lb., while for heating the buildings it only required 10 lb. He did not know or take into consideration that the exhaust steam was utilized at the Capitol plant for heating, while at the penitentiary they have not only sufficient, but an excess of exhaust steam for heating.

The illustration shows an arrangement for regulating makeup water to a tank heater to keep a uniform water level. It consists of a separate tank for the float, connected to the heater by ½-in. pipes similar to a water column on a boiler. This simple arrangement has proved satisfactory in use for three years; in fact I have not been able during the time to make any improvement in it.

C. P. LARSEN.

Bismarck, N. D.

A Question for Compressor Operators To Answer

Last summer I was troubled with a shortage of ammonia in our receiver in the heat of the day. I would then have to throttle down on the expansion valves until the liquid showed in the receiver. I found that if I closed the main valve between the receiver and expansion valve until about one-eighth of a turn from the closed position until liquid showed in the glass, and then opened it slowly, the liquid kept at the same level, I got the same result and did not have to move the expansion valves.

I would like to know from some reader what is the bad effect, if any, of the foregoing practice as done in an ice plant?

J. S. ILLINGWORTH.

Phoenix, Ariz.

INQUIRIES OF GENERAL INTEREST

Injector as Spare Boiler Feeder—What is the advantage of providing an injector for boiler feeding in addition to a regular boiler-feed pump? H. N.

The principal advantage is in providing a spare boiler feeder for use in case of failure or necessary disuse of the pump while undergoing examination, repairs or replacement. The injector will also be more economical than the pump as a boiler feeder at night, or other times when the feed water could not receive more heat from exhaust steam than the latent heat in the exhaust steam from the pump.

Maximum Size and Working Pressure for Lap-Joint Boilers—What is considered to be the greatest safe working pressure and largest diameter for cylindrical boiler-shells having longitudinal lap-seam riveted joints? H. V. S.

It is generally conceded in good practice and required by codes of rules for boiler construction, that the riveted longitudinal joints of a shell or drum which is over 36 in. in diameter should be of butt and double-strap construction, though this rule does not apply to the portion of a boiler shell that is stay-bolted to the firebox sheet; also, that the longitudinal joint of a shell or drum less than 36 in. in diameter may be of lap-riveted construction, but the maximum allowable working pressure should not exceed 100 lb. per square inch.

Tube Ends of Fire-Tube and Water-Tube Boilers—Why are not the tubes of water-tube boilers as well as those of fire-tube boilers required to have the ends beaded over? W. L. S.

There is no practical difference between the holding power of flared and beaded tube ends. If anything, tubes properly set with flared ends have greater holding power, as beading is likely to produce granulation of the material. The purpose of beading the ends of tubes of fire-tube boilers is to obtain better protection from the highly corrosive action of the hot gases on the outside of the tube ends and thereby retain greater strength in resistance against shearing or stripping action of the edges of the tube-sheet holes. The tube ends of water-tube boilers are not subjected to such destructive corrosion and, when properly set and flared, their holding power is much less affected by corrosion.

Unreliable Readings of Steam-Flow Meter—Would readings of flow of steam through a steam-flow meter that is calibrated to give the weight of steam flowing at 175 lb. gage and 2 per cent. moisture be correct for steam at 150 lb. gage and 2 per cent. moisture? C. F. W.

The reading would not be correct for the weight of steam at different pressures, because the weight discharged is the product of the density or weight per cubic foot multiplied by velocity, multiplied by the area of the pipe or aperture through which the steam is discharged. As may be found by consulting a table of properties of steam, such as Marks and Davis' steam tables, the density of steam at 175 lb. gage, or 190 lb. absolute, is 0.4157 lb. per cu.ft., and the density at 150 lb. gage, or 165 lb. absolute, is 0.3633 lb. per cu.ft. Hence, if the calibration for steam at 175 lb. gage is correct, readings on the same scale would be too high for steam at 150 lb. gage.

Difference Between a Synchronous and an Induction Motor—What is the difference between a synchronous motor and an induction motor? J. D. M.

A synchronous motor is an alternating-current generator run as a motor, its fields being excited with direct current the same as an alternating-current generator. This type of motor runs at an absolutely fixed speed which is equal to 120 times the frequency of the circuit the motor is operated from, divided by the number of poles in the motor. In the induction motor the rotor has no connection to any outside source of current. The rotor has either a winding made of copper bars shorted on two rings, one at each end of the core, or has an insulated winding connected through slip rings to an external resistance. The former is known as a squirrel cage rotor type, and the latter is known as the wound rotor type. The current is induced in rotor windings similar to that in the secondary of a transformer. The rotor is sometimes referred to as the secondary of the motor where the stationary element, or stator, is called the primary.

Allowable Pressure for Stayed Heads of Boiler—The ½-in. thick steel heads of a boiler are stayed by through stays, with stays screwed through the plates and fitted with single nuts outside. The pitch of the stays is 9 in. What pressure would be allowable for the flat plate? P. F.

The formula for maximum allowable pressure for braced and stayed flat plates, stayed with braces or staybolts of uniform diameter symmetrically spaced, is

$$P = C \times \frac{t^2}{p^2}$$

where

P = Maximum allowable pressure, pounds per square inch;
T = Thickness of plate in sixteenths of an inch;
P = Maximum pitch of the stays;
C = 135 for stays screwed through plates and fitted with single nuts outside of plate.

By substituting in the formula, the maximum allowable pressure is found to be

$$P = 135 \times \frac{8 \times 8}{9 \times 9} = 106.6 \text{ } lb. \text{ } per \text{ } sq.in.$$

Setting D Slide Valve—What is the method of setting the valve of a 10 x 18-in. D slide-valve engine and how much lead should be allowed? L. J.

If there is a rocker, lengthen or shorten the eccentric rod so the rocker-pin in the end of the eccentric rod will travel the same distance on each side of the position in which the rocker-arm is square with the eccentric rod. Remove the steam-chest cover and lengthen or shorten the valve rod as may be necessary to cause the valve to open one steam port as much as the other when the engine is turned over. Next, place the engine on a center and set the eccentric to that position on the shaft that will have the port uncovered about 1-32 in. for admission of steam at the beginning of the stroke. Then turn the engine over to the other center and observe whether there is the same port opening. If the lead or opening is not the same for both centers, it can be equalized by further adjustment of the length of the valve rod.

The purpose of lead is to admit steam to the cylinder before the piston has arrived at the end of the stroke, thereby acting as a cushion to assist in the easier reversal of the piston and coincidently reciprocating parts; also to supply the steam passages and clearance spaces with steam at full steam-chest pressure by the time the piston reverses its motion; and also to obtain larger port opening during the early part of the stroke. With a D slide-valve, greater lead is accompanied by earlier cutoff and also earlier release and earlier closing of the exhaust. Hence, the best amount of lead to be given depends on the design of the engine, the steam chest pressure and average load. With the valve travel equalized, or made central over the ports, the best setting of the eccentric usually is that which secures an amount of lead that is necessary for smooth running of the engine.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

The Fuel-Oil Supply and Its Use*

Fuel-oil production in the United States last year corresponded to about 37 1/2 million tons of coal. Oil is so scarce that ships may demand the entire output. Price on the Pacific Coast has trebled; the Northwest is practically without oil. The Mexican fields are the only lasting source of oil supply for the East. E. H. Peabody has an excellent paper on the economical use of fuel oil.

W. G. WILLIAMS:[1] Prior to 1915 fuel oil offered coal keen competition in many parts of the country, but war conditions have placed a different aspect on the situation, and it is safe to say that the present conditions are far more likely to prevail after peace is declared than that pre-war conditions will obtain.

The requirements for petroleum products of the lower end points necessarily keep pace with the growth of the internal-combustion engine; that the production of crude petroleum has not kept pace is evidenced by the reduction of crude in storage. In 1916 there were 162,000,000 bbl. of crude in storage, and at the present rate of reduction this reserve will be exhausted in 1919.

According to available information, slightly over 300,000,000 bbl. of crude oil were run through American refineries in 1917, and from this 102,000,000 bbl. of gasoline and kerosene, and about 150,000,000 bbl. of gas oil and fuel oil, were produced. This fuel oil (considering gas oil as fuel) corresponds to a coal production of 37½ million tons, which is hardly to be considered in comparison with the actual and known potential production of coal.

Ships May Demand All Fuel Oil Produced

Certain localities and requirements make the use of other than liquid fuel practically out of the question. On the Pacific Coast oil will be used to the exclusion of coal until one of two things occurs—production of crude petroleum falls off, or a method is discovered of converting the output of crude into gasoline. In the marine industry oil is practically the ideal fuel, and with the enormous increase in shipbuilding in the United States it is not too conservative to say that our fuel-oil output is destined for almost exclusive use on shipboard.

It is true that the maximum output of the Mexican fields is still an unknown quantity, and that the known oil fields are only a small part of those yet to be discovered, but against this must be considered the proven life of the fields and the efforts to convert crude petroleum into gasoline exclusively.

With the gigantic strides that are being made in the application of internal-combustion engines for motive power, the effort to produce a corresponding increase in the fuel for these engines is taking two forms—an increase in production of crude and of gasoline from the crude. How little these efforts are being rewarded is shown by the decrease in production in Kansas, Oklahoma and Texas fields of 82,000 bbl. per day since last October, and the practical failure of the "cracking" processes so far developed.

Any calculations based on the use of petroleum as fuel are, however, rendered valueless by the fact that any hour of any day may witness the development of a new oil field which will produce petroleum in such quantities that its use as fuel would largely supplant coal. The exhaustion of known fields is no bar to the discovery of new and larger producing areas, and I believe it is a wise engineer who keeps this possibility in mind, just as he would the ultimate development of a small steam plant into one of a size to eventually accommodate automatic coal-handling and firing equipment, and I believe this is particularly applicable to those of us doing business west of Pittsburgh.

C. H. DELANY:[2] To engineers on the Pacific Coast where fuel oil has for many years been the only fuel available, the problem at present is, what fuel can be substituted for fuel oil, rather than to what extent can fuel oil be substituted for coal.

During the last two years the price of fuel oil on the Pacific Coast has almost trebled, and in the Northwest its use has practically ceased, other fuels being substituted for it. In California, where there is practically no coal available, the use of fuel oil still continues, but as the consumption at present is considerably greater than the production, it is questionable how long its use can be continued without restrictions.

Oil-Fuel Shortage Will Grow More Acute

The situation will shortly grow worse on account of the immense quantities of fuel oil required for the Navy, especially for the large number of destroyers that are now being built. It seems, therefore, that unless there is a considerable increase in the production of fuel oil, it is useless to discuss the possibility of its being substituted for coal; however, there is always a possibility of new oil fields being opened up.

In Table I a comparison is given of fuel oil with coal of heating values varying from 10,000 to 15,000 B.t.u. per lb. The heating value of the oil is given as 18,500 B.t.u. per lb., which is a fair average value for California oil, the variations from this value being small. It is well known that with good grades of semibituminous coal better boiler efficiency can be obtained than with the low-grade Western coals, and to make this comparison fairly correct for the different grades of coal, an efficiency of 60 per cent. has been assumed for coal having 10,000 B.t.u. per lb., and 75 per cent. for coal having 15,000 B.t.u. per lb., with intermediate values for the coals that lie between these extremes. As the heating value of coal is invariably given on the basis of dry coal, and as coal when purchased invariably contains a considerable proportion of moisture, it has been assumed that the coals considered in this comparison contain 6 per cent. moisture. In the case of fuel oil the water content does not usually exceed 1 per cent., and this value has therefore been used in the comparison.

TABLE I. COMPARISON OF FUEL OIL WITH COAL OF VARIOUS HEATING VALUES

(Coal Containing 6 Per Cent. Moisture)

	Coal						Oil
B.t.u. per lb. dry fuel	10,000	11,000	12,000	13,000	14,000	15,000	18,500
Boiler efficiency, per cent.	60	63	66	69	72	75	78
Dry fuel per boiler hp., lb.	5.58	4.82	4.22	3.73	3.32	2.97	2.32
Fuel as fired per boiler hp., lb.	5.94	5.13	4.49	3.97	3.53	3.16	2.34
Coal equivalent to 1 bbl. oil (42 gal.), lb.	851	737	645	570	506	454	....
Price of 1 ton (2000 lb.) of coal equivalent to oil at $2 per bbl., dollars	4.70	5.43	6.20	7.03	7.92	8.82	....
Price of 1 bbl. of oil equivalent to coal at $5 per ton, dollars	2.13	1.84	1.61	1.42	1.26	1.13	....

The comparison given here considers only the actual value of the fuel itself. An oil-fired plant is considerably cheaper to build than a coal-fired plant, owing to the lack of coal-handling apparatus, mechanical stokers, etc.; furthermore, the labor in the oil-fired plant is much less than in a coal-fired plant, consequently the actual comparison for any particular plant will be somewhat more favorable to oil than is shown in Table I.

Automatic Regulation of Fire

One of the greatest advantages of the use of oil as fuel is that it is possible to regulate the firing entirely automatically. It is well known that in the modern power plant the efficiency obtained depends very largely on the personal element in the fireroom. This personal element

*From papers contributed to the Fuel Session at the June meeting of the American Society of Mechanical Engineers, Worcester, Mass.

[1]Efficiency engineer, Empire Gas and Fuel Co., Bartlesville, Okla.

[2]Pacific Gas and Electric Co., San Francisco, Calif.

has been largely eliminated in the engine room by making automatic the regulation of modern prime movers. In the fireroom, however, it is customary to depend entirely on the judgment of the fireman to regulate the supply of air that will insure commercially perfect combustion and give the highest efficiency. By making this regulation automatic the method of operating the plant changes, for it is then only necessary to adjust the fires at the start, and if the automatic regulator is reliable, it will keep the fires in proper adjustment for all loads.

Automatic regulators are now on the market for oil burning, which regulate the quantity of oil, the quantity of atomizing steam and the quantity of air required for combustion. While the main advantage of the automatic device is that it insures the boiler operating at maximum efficiency at all times, it also has the advantage of causing considerable saving in labor.

This advantage will be especially true in the case of small isolated plants where the firing is of poor quality and where the cost of labor is large in proportion to the quantity of fuel burned, and it is in these small plants scattered throughout the country that the greatest benefit would be derived if it were possible to substitute fuel oil for coal.

C. W. KOINER:[3] No relief can be looked for in the East from the substitution of fuel oil for coal except for ocean-going vessels and, possibly, to a limited extent, for the reason that this oil would have to come from the Southern and Mexican fields and the conditions in Mexico are so chaotic that the full supply of oil that these fields are capable of putting out cannot be depended upon.

HYDRO-ELECTRIC PLANTS INTERCONNECTED

Practically all hydro-electric plants in California have been linked together from the southern to the northern part, a distance of approximately 800 miles, with a view of eliminating oil-burning plants wherever possible. The oil reserve in California, during the months of January, February and March, was drawn on to the extent of 1,655,000 bbl. The month of April, however, showed a little improvement. The production was increased and the lack of shipping facilities for carrying the oil to its destination prevented the reserve being depleted as much as during the past year.

VAST DEPOSITS OF OIL SHALE

Guy Elliott Mitchell, of the United States Geological Survey, in an article in the *National Geographic Magazine* for February, 1918, stated that the total production of petroleum in the United States up to 1918 was 4,255,000,000 bbl. In regard to future production, he estimates that the total amount in the ground, some of which lies very deep, is about 7,000,000,000 bbl. This is small compared with the quantity of oil that can be extracted from our oil-shale deposits. He tells us that American deposits of oil shale will supply enormous quantities of oil in the future. It is estimated that 20,000,000,000 bbl. can be obtained from the oil shale in Colorado alone; that certain ranges of mountains in which these deposits are located carry thick beds of rock that yield 30 to 100 gal. to the ton. The shale deposits of Indiana are estimated to carry 100,000,000,000 bbl. of oil. There are also deposits in Wyoming, Nevada, Illinois, Kentucky, Ohio, Pennsylvania, Tennessee and West Virginia; therefore our oil supply for the future is assured, even though we fail to develop additional oil territory other than the shale deposits.

ERNEST H. PEABODY:[4] The data in Table II are from the preliminary report of the United States Geological Survey, and show that in the year 1917 the production in the United States had increased some 14 per cent. over 1916, reaching the record-breaking total of nearly 342,000,000 barrels.

At least 40 per cent. of all the crude oil produced will be available for fuel purposes. Notwithstanding the great amount required for war purposes, particularly in the Navy and the rapidly increasing merchant marine, it is well worth asking whether or not oil fuel can be obtained for steam production on shore.

No definite statement can be made as to the availability of oil in any particular locality, especially under the existing conditions. At all times, in fact, this is purely a local question. In California, until recently our largest oil-producing state, and where no coal of importance is mined, oil will doubtless continue to displace coal. In Pennsylvania, on the other hand, there are great coal deposits, while the oil produced is of a variety exceedingly valuable for refining purposes, so that coal as fuel holds decided superiority over oil except for special uses. In other parts of the country the balance may fall either way—as the production and the demand vary and as the transportation problem may determine. It would seem as if the Middle West should be well supplied with oil, as Oklahoma now produces more than one-fifth of all the oil in the world. Oklahoma wrested the production laurels from California in 1915.

TABLE II. FUEL-OIL PRODUCTION BY DISTRICTS IN 1916 AND 1917

Field	1916 Barrels	1917 Barrels
Appalachian	23,009,455	24,600,000
Lima-Indiana	3,905,003	3,500,000
Illinois	17,714,235	15,900,000
Oklahoma-Kansas	115,809,792	147,000,000
Central and Northern Texas	9,303,005	11,000,000
North Louisiana	11,821,642	8,700,000
Gulf Coast	21,768'096	24,900,000
Rocky Mountain	6,476,289	9,200,000
California	90,951,936	97,000,000
Other Fields	7,705	.....
	300,767,158	341,800,000

The Mexican production, while already very large (nearly forty million barrels in 1916), has been restricted on account of a deficient amount of tonnage to take the oil away. With adequate shipping facilities it is probable that the Mexican fields will constitute the natural source of oil-fuel supply for New England and the Atlantic States. There is one well alone in Mexico, the Cerro Azul, estimated to have flowed 263,000 bbl. a day, and it is interesting to speculate on what these fields may finally produce.

All indications point to the probability that there are enormous quantities of oil yet hidden in the earth's crust to be one day brought forth by the prospector.

CARE REQUIRED TO PREVENT WASTE OF OIL

A coal fire in the hands of a lazy or incompetent fireman may indeed fall far below the desired standards of excellence; but it can only reach a certain minimum level of efficiency, and then it will go out. Coal is, in fact, of such a nature that it will quietly stand a certain definite loss in economic results, and then it will quit.

With oil there is no limit to the possible wastefulness that may exist. Give it poor burners, improper furnace conditions or not enough draft, and it will smoke and sputter and drip oil and waste itself away, but never give up. Give it too much air, a hundred times too much, and the fire will burn, the oil will disappear, the flame will be bright, there will be no smoke; but the waste may be so great that the boiler will not make enough steam to run the feed pump, even with the best furnace and burner arrangement.

It is approximately true that 1 lb. of oil equals 1½ lb. of coal in actual steam-making results. Roughly, this is equivalent to saying that 200 U. S. gal. of oil equals one ton (2240 lb.) of coal, or one ton of coal equals about 4½ bbl. of oil.

A handy rule, but like the rest only approximately correct is this: When the price of coal in dollars per ton (2240 lb.) is double the price of oil in cents per U. S. gallon, the cost of fuel for producing a certain boiler capacity will be the same for both fuels. Thus two-cent oil equals $4 coal, or four-cent oil equals $8 coal.

This rule takes into consideration the probable increased boiler efficiency obtainable with oil, but makes certain assumptions concerning the heat values of the two fuels and the weight of the oil per gallon, which, while generally representative, may or may not be correct in any specific instance.

Generally speaking, one oil burner will be required for, say, 350 to 400 boiler hp., and one oil fireman can attend to about ten burners.

Reliable tests with oil fuel have shown that the boiler efficiency (that is, the percentage of heat units in the oil

[3]General Manager, Municipal Lighting Department, Pasadena, Calif.
[4]Consulting Engineer, Babcock & Wilcox Co., New York City.

which is actually absorbed by the steam leaving the boiler) may be as high as 83 to 84 per cent., although 78 to 80 per cent. may be considered as good work, or even 75 per cent., in regular operating conditions. With coal fuel, while reports have been published by some pseudo authorities showing over 80 per cent., the writer believes that such high results with coal can be obtained only with very large boiler units and the most efficient mechanical stokers. Certain it is that in hand-fired plants, 75 per cent. is about the maximum, while 65 per cent. may be considered very good average work.

The advantage possessed by oil in respect to increased efficiency is due primarily to the small amount of air required for complete combustion in excess of the theoretical amount. This may be reduced to 10 per cent. with oil, while the best tests with coal, hand-fired, show about 50 per cent., and good everyday working conditions run as high as 80 or 100 per cent.

Maintenance charges are decidedly less than with coal. It is true that higher furnace temperatures with oil as a rule require a better quality of firebrick, and danger may result to boiler-heating surface with improper furnace arrangements and burners. These points are easily cared for.

Theory of Burning Oil Is Different

The theory of burning oil is different and radically distinct from that controlling the burning of solid fuel. Pulverized coal, of course, in some respects closely approaches the character of burning oil, but coal fired by hand or by stokers remains substantially at rest during combustion, and the air is brought to it. In the case of oil, the fuel is moving and the air moves with it.

In varying the rate of combustion of coal, the amount and velocity of the air through the fuel bed is altered—the intensity of the draft is increased or decreased. In the case of oil, the amount of fuel itself and the rate at which it enters the furnace must be varied, and the amount of air entering with it must be increased or decreased to preserve the proper ratio.

The lighting of an oil fire is a simple process. The oil pump is started to give the necessary oil pressure at the burners. The draft is opened to provide sufficient air for combustion. A lighted torch is then placed directly under the burner tip, and the oil is turned on. If the oil is at the proper temperature and the atomizer is working properly, the spray at once bursts into flame. The spray must never be started without first lighting the torch; that is, no oil must be injected into a "dark furnace," for if it is, an explosive mixture may be formed in the furnace which will cause damage if ignited.

There is little or no difference in the action of compressed air and steam in atomizing oil as far as boiler work is concerned, and if the air is compressed to over 30 lb. per sq.in. there is no special difference in the design of the burner itself.

So far as the steam-boiler furnace is concerned, however, the prospective user of oil may forget the air atomizer, the one instance in which its use might be considered being that in which the saving of fresh water (consumed by the steam atomizer) is a matter of importance. And in this case a mechanical atomizer will probably do the work effectively and will be preferred.

Selection of Type of Burner

As between the claims of the steam atomizer and the mechanical atomizer, the issue is not as clear-cut. On board ship, except in the case of harbor vessels or those making port every day, the steam atomizer has given way to the mechanical atomizer, where the saving in fresh water for the boiler makes the use of the latter type practically imperative.

There is practically nothing to choose between the two types in operating results under equivalent conditions. The steam atomizer is, however, more flexible, that is, the individual burner has a greater range in capacity; it costs less to install, notwithstanding that it requires two lines of pipe (oil and steam), whereas the mechanical uses only one and that for the oil. It is more readily applied to a coal-burning furnace, and, conversely, the furnace is more quickly converted back again to coal. It requires a lower oil pressure and not so high a temperature for viscous oils. It will also, in general, require less draft to operate. Furthermore, where special arrangements of burners are required, as in the case of the so-called "back-shot" burner (placed at the rear of the furnace), the steam atomizer is susceptible of a wide range in design which has been found useful.

Oil Pressure and Temperature

For steam (or air) atomizing burners, oil pressures of 25 to 50 lb. at the pumps are adequate, and under certain conditions even less pressures. Overhead tanks a few feet above the burners, feeding the oil by gravity, have been employed, but this is inadvisable on account of danger of fire, and pumps are usually employed. Mechanical burners require pressures of 50 to 250 lb. at the burner tip, 200 lb. being a favorite pressure for the designer. The wide range of pressure is useful in adjusting the burner capacity. A steady oil pressure is a necessity for oil burners, a vital necessity for mechanical burners. Therefore large air chambers on the oil line are needed if the usual duplex reciprocating pump is used. Rotary pumps are being introduced in the Navy, and recently the screw pump has come into vogue. These pumps give a steady pressure of oil with little or no air cushioning, and the screw pump, particularly, seems to possess great possibilities for this work.

The matter of heating the oil is rather of a mechanical nature as its importance bears on the viscosity of the oil rather than on any thermal advantage. Steam atomizers will handle more viscous oil than the mechanical type, therefore steam heaters using exhaust steam from the pumps and capable of heating the oil to 100 deg. to 125 deg. F. are usually satisfactory. The mechanical burner requires that the viscosity of the oil be reduced to 8 to 10 deg. Engler to spray properly, and this means that the oil (according to its viscosity) must be heated to 120 deg. to 280 deg. F. The latter temperature is required for heavy viscous oils that are appearing on the market to a greater and greater extent. In a mechanical-burner installation it is evident that the oil heater is a most essential part of the equipment.

Importance of Air Regulation

To a certain extent the amount of air being delivered to an oil fire is indicated by the color of the flame, a very bright, intense white (so desirable with coal) usually indicating that too much air is being used, with a resulting loss in efficiency. Judging the fire by the flame, however, is only approximate; and it is better to resort to the simple device of diminishing the air supply until a light-brown haze appears at the top of the chimney. This is preferable to a clear stack, as the latter gives no indication of excess air. The light haze is not at all objectionable and in fact represents good conditions—and this is a most important point—the smoke which produces the haze does not come from one or two burners only, while all the rest are working with oil. Complete combustion in the furnace (that is, combustion in which all the carbon is burned to CO_2 and no CO is present) will give an analysis with coal in which the CO_2 content, plus the free-oxygen content, will add up considerably higher in amount than an analysis of the products of similarly complete combustion of oil. The same percentage of CO_2 in the gas sample from coal indicates a much greater excess of air over that theoretically required than when oil is being burned. However, complete combustion of oil can be secured with a much lower amount of excess air than coal fuel; and it happens, therefore, that 14 per cent. CO_2 in both cases represents the same satisfactory conditions in the furnace with both fuels.

The amount of air theoretically required for the complete combustion of fuel oil of course varies with the composition of the oil, but it may be considered that about 14 lb. or 183 cu.ft. at 60 deg. F. represents the average.

In oil burning, "furnace volume" possesses a function similar to that of "grate area" in burning coal fuel. The rate of combustion of oil per cubic foot of furnace volume may be increased or decreased according to the intensity of the draft. A large furnace is necessary, therefore, if the draft is low, and the furnace can be made smaller if the

draft is increased. This effect of furnace volume on the rate of oil combustion is often ignored or misunderstood; but it is of prime importance.

A high furnace temperature promotes the combustion of oil. Owing to the less quantity of excess air, oil furnaces are usually higher in temperature than those burning coal, so that good-quality firebrick with a fusing point at least 3000 deg. F. should be used. Notwithstanding the higher temperature, if the burners are set and operate properly so that no flame impinges on the wall and no hard carbon is deposited, the wear and tear should not be great.

W. N. BEST:[5] The direct answer to this inquiry is: First, in whatever equipment oil as a fuel is found to be cheaper than coal; second, whenever by its use an increased output is secured; third, wherever a superior quality of metal is produced; fourth, to safeguard against shutdowns in power plants through shortage of other fuels; and fifth, to carry peak loads in power plants.

We will first consider oil in power plants. If the coal used has a calorific value of 14,000 B.t.u. per lb. (good bituminous coal) it requires 147 gal. of oil to represent a long ton of coal (2240 lb.), the oil having a calorific value of 19,000 B.t.u. and weighing 7.5 lb. per gal. With oil at 5c. per gal., this would be equivalent to coal at $7.35 per ton delivered in the coal bin. The larger the power plant the more attractive is oil fuel, owing to the fact that one man can fire and water-tend twelve 300-hp. boilers. There are no ashes to handle and cart away. Of course the saving on all labor such as extra firemen and ash handling will vary in accordance with the number and size of boilers in the plant. I only mention this as a concrete illustration as to how an engineer can calculate the cost of the two fuels, so that anyone can definitely determine if oil is attractive or not. The data used have been compiled from hundreds of tests.

COAL IS CHEAPER IN THE EAST

In the eastern part of the United States oil as a fuel is rarely found to be as cheap as coal when used exclusively as a fuel in boilers; but last winter's experiences fully demonstrate the necessity of having coal-fired power plants equipped with oil as an emergency fuel owing to the uncertainty of the coal supply, and also the delay in delivery occasioned by the shortage of coal cars. It is the writer's opinion that no power plant today is safe without apparatus for the use of oil as an emergency fuel. Also, oil may be used as an emergency fuel to carry peak loads on either hand-fired or stoker-fired boilers. The liquid-fire injecting apparatus may be placed in the side wall of the boiler, midway between the bridge-wall and front-end setting or may be placed in the front-end setting and will not interfere with the fireman or stoker. A lever is used to operate the slide gate which admits the air to support combustion, independent of the air admitted through grates or stokers; thus, if it is desired to operate the oil burner at 15 per cent. of its capacity, the gate is opened only sufficiently to admit just enough air for the perfect combustion of that amount of fuel in combination with the coal. It can be so operated that no superfluous air is admitted into the firebox, by simply moving the lever to any position required. As soon as the supply of coal is entirely exhausted, the grates or stokers can be covered with cinders and oil burned exclusively. When a supply of coal is again secured, the cinders or ashes can be removed, the burner shut off and the air gate closed while only coal is again burned.

There are thousands of boilers in power plants and in gas works where to carry peak loads oil or tar is burned in combination with coal, breeze, etc. Also in power plants where bagasse is used as a fuel, often oil is necessary to aid that fuel in obtaining the full rating of the boiler. Oil is ideal for this purpose, for by its use one can control and maintain the steam pressure as desired. It ordinarily requires three gallons of oil to each ton of bagasse burned.

I believe all marine boilers now burning coal should be equipped with oil as an emergency fuel; especially should this fuel be used in the time of war, for by its use in combination with coal the boilers can be operated at 200 per cent. overload in a few minutes, thereby increasing the speed of the vessel to its maximum.

In forging plants oil should be used as fuel, for thereby the manufacturer secures the maximum output and a better quality of metal. In this practice only 80 gal. of oil is equivalent to a ton of good coal.

In heat-treating furnaces (low temperatures) 72 gal. of oil is required to represent a ton of coal of the calorific value referred to. Since it is true that steel is only as valuable as it is heat-treated, oil is superior to coal, for by its use in modern furnaces any temperature required can be attained and maintained at the will of the operator, and an even distribution of heat obtained over the entire charging space of furnace.

In foundry practice oil is an incomparable fuel for core ovens, and in steel foundries for mold-drying ovens, etc.

In chemical plants where accuracy of temperatures is very important, especially in the manufacture of dyes, oil fuel is a necessity.

In welding flues 58 gal. of oil represents a ton of coal (all coal and oil referred to here have the same calorific value). This is due to the fact that it is necessary to coke a coal fire before welding two pieces of metal together, and in this process of coking the coal all the volatile gases are wasted.

FUEL-OIL CONTROL AFTER THE WAR

In conclusion, I would say that owing to the superior qualities of oil, it belongs to that portion of the manufacturing world having forging and heat-treating shops, foundries melting various kinds of metals, and power plants for which an emergency fuel must be provided. I am confident that when the war is over the nation having control of the most oil wells will be the largest manufacturer in the world; and if Germany controls the oil fields of Rumania and the Baku fields of Russia, our country's greatest competitor in the manufacturing world will be Germany, although we (the United States) now contribute 62 per cent. of the world's production of crude oil. We must conserve this fuel and only use it where it can best serve the nation.

R. J. S. PIGOTT:[6] One very important point militating against the substitution of fuel oil for coal (even if a supply were obtainable, which it is not) is the relative price of fuel oil and coal per million B.t.u. In all but the most favored localities, coal is about one-half or less the cost of fuel oil per million B.t.u. For instance, at Bridgeport in 1915 coal was $4 a ton (14,250 B.t.u.) and oil 4c. per gal. (19,000 B.t.u.); the relative cost was 12.65c. per million B.t.u. for coal and 29c. per million B.t.u. for oil. Anyone contemplating the substitution of oil for coal would be faced with a doubled cost of steam production. The saving in labor due to elimination of coal- and ash-handling is insignificant. The difference in efficiency is now next to nothing, since the development of the underfeed stoker has put the coal-fired boiler practically on a par at all points with oil.

FUEL OIL IN INDUSTRIAL HEATING PROCESSES

One very large source of waste, and an immense opportunity for saving, lies in our industrial heating processes. We have vast amounts of coal, oil and gas used in factory processes for heat-treating, annealing, pit fires, forge furnaces, etc., in nearly all of which cold work is introduced directly into an intensely hot chamber under direct flame, and no attempt whatsoever is made to use the heat in the flue gases.

In connection with the writer's work at the Remington Company, we tested several types of oil-fired forge furnaces, as well as gas-fired brazing and other small operation furnaces, finding the efficiency between 10 and 15 per cent. In some cases surface combustion or semisurface combustion furnaces of our own design were substituted for bunsen-flame types, cutting down gas to one-third and in two cases to one-fifth the former amounts. We should by all means employ pre-heating methods in our shop operations, making use of the familiar counter-current principle so universally

[5] President, W. N. Best, Inc., New York, N. Y.

[6] Bridgeport Brass Works, Bridgeport, Conn. Associate Member A.S.M.E.

adopted in such heat-transfer apparatus as condensers, feed heaters and boilers. There is no doubt that we could at least double the present poor efficiency of our usual primitive shop furnace.

Referring to the coal situation, the admirable work of Mr. Potter and Mr. Cole in Pennsylvania should have the hearty support of this society, since it is a method of curing the cause, not the effect—which eases the situation from both the coal-burner's point of view and that of the transportation company. I therefore respectfully submit the following resolution:

Whereas, A large proportion of the shortage of fuel is due to the reduction of capacity and efficiency occasioned by the increase in noncombustible impurities in the coal as furnished from the mines, due chiefly to negligence on the part of the operators, and to the consequent increase in tonnage hauled for a given total heating-value.

Whereas, Mr. William Potter, Fuel Administrator of Pennsylvania, has taken effective steps to force the proper cleaning of coal by establishing inspection at the mines, standards of quality and punishment for infraction; be it

Resolved, That the American Society of Mechanical Engineers indorse and support the action of the above-mentioned Fuel Administrator of Pennsylvania.

Anthracite and Bituminous Efficiency

Speaking before the American Society of Mechanical Engineers, at Worcester, Mass., Secretary Cole of the fuel conservation division for Pennsylvania said in part:

During the arctic-like weather of the second half of last winter the demand for coal skyrocketed to a point never before reached in this country. At the same time the quality decreased with amazing rapidity, aggravating the existing fuel famine to a degree not readily credible.

The tonnage of inferior coal delivered in January was so large as to cause the Fuel Administration to formulate rulings limiting the percentage of slate, bone and under sizes that would be permitted by the Government in all sizes of anthracite.

The effectiveness of inspection at the mines and destination points may be indicated by the reports for May. These show less than one-half of 1 per cent. of daily anthracite production of more than a quarter million tons was condemned by Federal inspectors for May. This coal was condemned at the mines, and reprepared for delivery. Vast improvement can be better visualized when it is recalled that more than 50 per cent. of marketed tonnage during January and February contained excessive amounts of impurities.

It is the observation of the Fuel Administration that steam sizes of anthracite, containing 40 per cent., are so inefficient in generating steam that the cost of such fuel is commercially prohibitory.

Any steam anthracite containing more than 30 per cent. of slate or bone is too expensive for the manufacturer to purchase today, according to our observation. All steam coal containing more than 20 per cent. of impurities is condemned when it comes under the observation of the Fuel Administration. The effect of increase of impurities in domestic sizes of anthracite is more marked than in steam sizes. Excellent results are obtained with pea coal containing 8 to 10 per cent. of slate and the same amount of bone.

Pea coal containing 20 per cent. of slate is worthless for low-pressure boilers. In high-pressure practice, fairly good results can be obtained but ashes must be removed at frequent intervals, and more attention given to the fire. In high-pressure practice, fairly good service can be obtained with 25 per cent. of slate, but the cost of such fuel is virtually prohibitory. The larger the size of anthracite, the lower must be the percentage of impurities to obtain maximum service. No shipments of pea coal with more than 12 per cent. slate are permissible.

Chestnut coal containing 20 per cent. of slate is so inferior that any price for such fuel is exorbitant. All nut coal containing 7 per cent. of slate is condemned by the Fuel Administration.

Stove coal containing 5 per cent. of slate and 6 per cent. of bone gives maximum service. At 6 per cent. of slate and 7 per cent. of bone the result is an increase of 8 per cent. in fuel costs. This size coal containing 8 per cent. of slate and 9 per cent. of bone shows maximum possible amount of impurities that can be used by domestic consumers, discounting high cost of such fuel. Any percentage above this renders the fuel worthless. Egg coal should not be used when the amount of slate is more than 4 per cent. and 5 per cent. of bone.

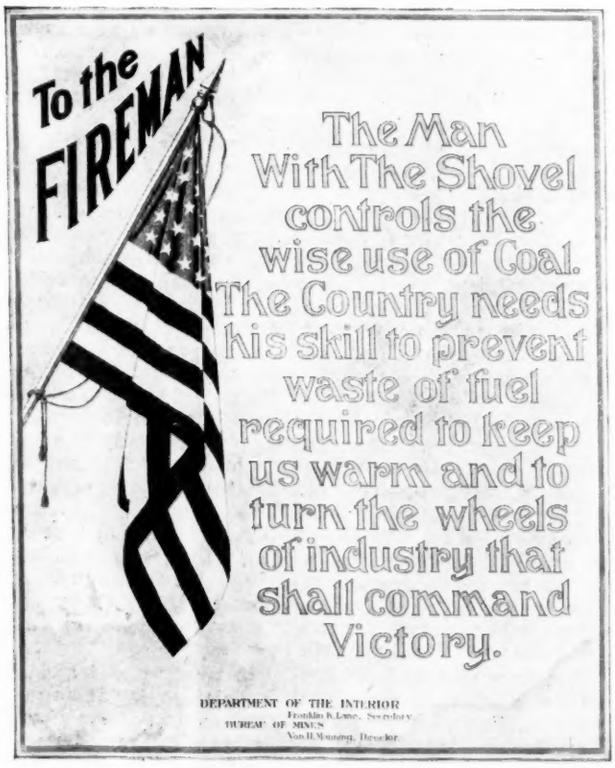
It can be stated without question that bituminous containing more than 2 per cent. of sulphur should not be used for locomotive purposes, and 2½ per cent. is the maximum that most standard railroads accept. More than 8 per cent. of slate and other impurities makes coal dear at any price.

Stabilizing Crude-Oil Prices

The National Petroleum War Service Committee has been asked by the Oil Division of the United States Fuel Administration to coöperate in the development of a comprehensive plan to stabilize the price of crude oil and to establish definite and fixed differentials for the various qualities of crude. The committee is making a thorough study of the subject, and with the assistance of its Advisory Committee is consulting the various factors in the industry with a view to suggesting a plan that will stimulate maximum output and give reasonable earnings.

Mr. Requa, Director of the Oil Division of the United States Fuel Administration, in a letter to A. C. Bedford, Chairman of the National Petroleum War Service Committee, states his belief that such a program can best be outlined by the committee rather than by the Government, because such a program "involves the welfare not alone of the producer but of all branches of the business." Mr. Requa suggests consideration of the California plan, under which a base price is established for oil of a given gravity with additions for every degree of higher gravity and deductions for every degree of lower gravity than the established standard.

Many engineers forget, or never knew, that in a nonreversing engine only one side of the crankpin gets any wear. Think this statement over, and you will find it true.—*Marine Engineering.*


To the FIREMAN
The Man With The Shovel controls the wise use of Coal. The Country needs his skill to prevent waste of fuel required to keep us warm and to turn the wheels of industry that shall command Victory.
DEPARTMENT OF THE INTERIOR
Franklin K. Lane, Secretary
BUREAU OF MINES
Van H. Manning, Director

Poster to the Fireman

This attractive poster, in colors, 19 x 24 inches, has been issued by the United States Bureau of Mines. The bureau is anxious that these posters be distributed as widely as possible in the boiler rooms of the country, and will send a copy to any person who makes such a request. All that will be necessary is to address the Bureau of Mines, Washington, D. C.

Cold Accumulators and Their Application*

By ERNST S. H. BAARS

States the purposes of temperature holdover tanks used in the refrigerating industry and describes a new holdover tank which uses a weak calcium-chloride solution which is frozen. The molecular behavior of liquids and salt crystals are interestingly described.

THE term "cold accumulator" sounds paradoxical because, technically speaking, it is not possible to accumulate cold. What is actually meant is a surplus refrigerating capacity stored up for use later on. The apparatus had, therefore, better be called a "Holdover Tank," because it keeps a room cold during a short period while the refrigerating plant is shut down; it "holds over" the low temperature from the time the refrigerating plant is shut down until it is started again.

Holdover tanks are used principally in connection with small refrigerating plants that are operated a number of hours a day and not continuously. But they are also desirable for automatically controlled refrigerating plants to prevent too frequent starting and stopping of the compressor and wearing out of the controlling apparatus. The action of the holdover tank is practically the same as ice, but the disadvantages of ice are overcome. The holdover tank always consists of the tank itself with proper supports, evaporating coils placed into the tank, and the requisite quantity of brine.

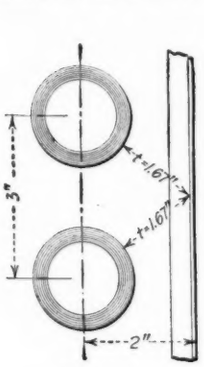


FIG. 1

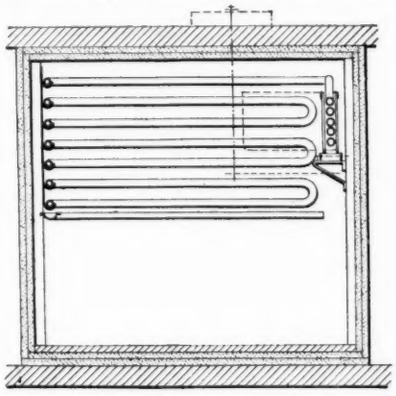


FIG. 2

FIGS. 1 AND 2. COILS OF HOLDOVER TANK

Fig. 1—Spacing of coils. Fig. 2—Section of holdover tank

Holdover tanks may be divided into three types: The first is the old, well-known brine tank in use since the beginning of the refrigerating machinery industry. This type of tank is, in fact, a centralized cooling station and can be placed in any available space, and any number of rooms or apparatus may be cooled with it. A brine pump, however, is required to circulate the brine through the rooms to be cooled, and this pump must be kept operating while the refrigerating plant is shut down. These brine tanks are also used in connection with large refrigerating plants. There are advantageous features; namely, these tanks will take care of a temporarily increased load, that is, a load greater than the capacity of the refrigerating machine allows for, and in case of a breakdown the cold brine will hold the temperatures for some time. As a third advantage may be mentioned the saving of insulated space for storage of goods on account of the small space required for cooling surface, as compared with direct evaporating piping and holdover tanks in the room.

*A paper read before the Engineers Society of Milwaukee.

The second type of holdover tank consists of a tank with the requisite amount of evaporating coils and a highly concentrated solution of chloride of calcium brine. Each room to be cooled has one or more of these holdover tanks. In addition to the piping submerged in the brine, some piping is also usually placed in the air. While the machine is running, the brine is cooled down about 20 deg. F., and during the remainder of the day, while the machine is shut down, the heat that enters the room through the walls is absorbed by the cold brine in the tank and gradually raises its temperature to a point where the refrigerating machine must be started again.

A few years ago I designed a third type of holdover tank, which has all the features previously mentioned, but the working of it is based on a different principle. Instead of a strong solution of calcium chloride, I use a weak solution and freeze it, and the following are superior features which I claim for it:

a. Only one-seventh of the volume of a brine tank is required, the other six-sevenths being available for cooling coils, or goods, to be stored.

b. The construction members of a room can be much lighter, because the tank, brine and supports weigh much less than in other systems for a given capacity.

c. A saving in calcium chloride is effected amounting to about one-eleventh of what the brine tank will require. This means a considerable reduction in the investment at present, when the price of calcium chloride is $40 per ton against $8 to $10 in former years.

The advantages of the frozen-brine system will be apparent from the following example, considering just one pound of brine and what it can do when absorbing heat:

The room to be taken under consideration may require a temperature of 32 deg. F. To obtain this, a suction pressure of 15 lb. must be carried, which allows the ammonia to evaporate at zero degrees Fahrenheit.

Under operating conditions the brine, in a tank of the second type described, is cooled from about 25 to 5 deg. during the day, if enough pipe is provided for the tank. To keep the brine from freezing, it must be made up into a solution containing 21 per cent. dry calcium chloride with a specific heat of about 0.72. Therefore, one pound of brine will absorb $Q = (25 - 5) \times 0.72 = 14.4$ B.t.u. The heat capacity of one cubic foot solution is then, according to Bureau of Standards tables, 1069 B.t.u.

With the frozen-brine type of holdover tank select a temperature of about 12 deg. F. for the brine to freeze. For this temperature a solution containing 15 per cent. of dry calcium chloride will be required. To form crystals, chloride of calcium requires water of about one-third of its weight, in our case 5 per cent. of the solution, leaving 80 per cent. of water to be transformed into ice should the solution be frozen.

When thawing, one pound of brine would be capable of absorbing

$$Q_1 = 0.80 \times 143.5 = 114.8 \text{ B.t.u.}$$

To make the comparison just, the following should be considered for proper comparison: After freezing at 12 deg. F., the frozen brine should be brought down to the same temperature, 5 deg. F., as the concentrated brine of the first example. Assuming the specific heat to be about 0.5, the frozen solution will be able to absorb

$$Q_2 = 0.5 \times (12 - 5) = 1.75 \text{ B.t.u.}$$

To make the comparison complete the thawed solution must be heated to 25 deg. F., amounting to

$$Q_3 = 0.8 \ (25 - 12) = 10.4 \text{ B.t.u.}$$

The heat that can be absorbed per pound of solution consequently amounts to

$$Q = Q_1 + Q_2 + Q_3 = 126.95 \text{ B.t.u.}$$

I should have taken into consideration the heat of fusion of calcium chloride, which is liberated when dissolving it, but I was unable to find any information to make correct

calculation. The small amount of calcium chloride present in the solution will permit neglecting this item.

One cubic foot of the weak solution is capable of absorbing $72 \times 126.95 = 9140$ B.t.u., which is about nine times that which one cubic foot of strong brine will absorb.

In practice the problem is a little different because the cooling pipes take up some space, so that one can figure about 14 B.t.u. per cubic foot for the tank in the first example, and 100 B.t.u. for the frozen-brine type tank.

For the successful operation of the holdover tanks with frozen brine, the tanks must have a special shape. It is known that if any solution is frozen very slowly, the water it contains is frozen out and the salt crystals fall to the bottom of the vessel, which makes it essential that no brine be located too far from the evaporating pipe, because the rapidity of freezing is inversely proportional to the square of the distance from the freezing surface. Doing this will make the salt crystals stay in the ice and be ready to go in solution with the water as soon as the temperature rises.

Another feature is the flexibility of the tank. It is well known that ice will burst a can in which it has frozen, should it happen that the brine of the freezing tank goes above 32 deg. F., and a little of the ice thaws and is again frozen. Something similar occurs every day in the brine tank of my design, and using corrugated sheets which will give not only a flexible but also a strong construction, will overcome this trouble when arranged so that the corrugations run vertically. It is needless to say that evaporating pipes should be arranged as near together as possible. The dimensions of such a tank, for example, are 4 in. wide over the corrugations, 24 in. deep and 9 ft. long. If the length of the room is 10 ft., I would place a vertical coil in this tank of 1¼-in. pipe, seven pipes high and 8 ft. 6 in. long over-all. It is also a good policy to feed the ammonia into this end of the pipe first; after passing the coil, the refrigerant should enter the cooling pipes in the air.

The question may arise whether apparatus like the last two are much in use, and in reply I wish to state that in this city the total number of tanks in which brine is cooled amounts to about 43, and those in which the brine is frozen, to about 36. This is quite a number, considering that the first ones were installed in 1912.

It may be of interest to investigate the fact that the freezing point of a mixture of salt or calcium chloride and water is lower than that of pure water, depending upon the proportion of salt in the mixture.

Molecular Movements of Liquids

In any liquid the molecules are in constant motion; they are vibrating back and forth and the temperature of the liquid is proportional to their mean velocity. Some of these, which are near the surface, travel in a direction perpendicular to the surface of the liquid, and any that have a velocity great enough to overcome the surface tension will break through the surface of the liquid and go into space. As the liquid is heated, the velocity of the molecules will be increased and more of them will leave the surface per time element. Since the molecules have a vibratory motion, some of those that leave the surface of the liquid will return to it, and this is the process that will take place during evaporation.

Solids, such as salt crystals, contain a certain amount of heat of solidification, and when these crystals break up this latent heat is liberated. The reason for this will appear at once if we consider the analogy between solution and evaporation, for just as the molecules of a liquid tend to escape from the surface into the air, so the molecules at the surface of the salt are tending to pass off and are only held back by the attraction of the other molecules in the crystal. If the salt is placed in water, the attraction of the water molecules for the salt molecules aids the natural velocity of the latter and carries them beyond the attraction of their associates. As the molecules escape from the salt crystals, two forces are acting on them, the attraction of the water molecules tending to increase their velocity and the attraction of the remaining salt molecules tending to diminish their velocity. If the latter force has a greater resultant effect than the former, the mean velocity of the molecules after they have escaped will diminish and the solution will be cooled; but if the attraction of the water molecules amounts to more than the backward pull of the dissolving molecules, the molecular velocity is increased and the solution is heated. An example of the latter action is the case of caustic potash or sulphuric acid when dissolved in water.

When a liquid will not dissolve a solid, we infer that the pull of the liquid molecules, added to the natural velocity of the molecules in the solid, is not sufficient to separate the latter from their associates. This may be the case in a salt solution at —8 deg. F. If a solution of one part of common salt to ten parts of water is placed in a test tube and immersed in a freezing mixture, the temperature at which ice begins to form will be several degrees below zero. The ice which does form will be found to be free from salt, and it is this fact which furnishes the key to the explanation to the foregoing statements and explains why the freezing point of the salt solution is lower than that of pure water. That is, cooling a substance to its freezing point means reducing its temperature, or reducing the mean velocity of its molecules sufficiently to enable the cohesive forces of the liquid to pull the molecules together into the crystalline form. In the freezing of the salt solution the cohesive forces of the water are obliged to overcome the attraction of the salt molecules as well as the molecular motion. The motion must be made less; that is, the temperature must be made lower than is the case with pure water in order that crystallization may occur. From this reasoning it would seem that the larger the amount of salt in the solution the lower would be the freezing point. This is actually the case, and the freezing point of a saturated salt solution is minus 8 deg. F. The foregoing is an explanation of the phenomenon involved, given to a friend of mine by E. M. Shealy, at that time assistant professor of steam engineering at the University of Wisconsin.

Why Salt Was Not Considered as Solution

In this connection I wish to refer back to the beginning of the article and explain why common salt was not considered as a solution for the frozen-brine holdover tank. One reason was because of the comparison that had to be made with calcium-chloride solutions, and the other because calcium chloride is best suited for the purpose. Calcium chloride does not actually form crystals as does common salt; it remains between the ice crystals in a more finely divided condition and therefore enters into solution more readily. Crystals of salt seem to require considerable time to dissolve, so that water will surround them before they are dissolved; the crystals will sink to the bottom of the tank and stay there because no agitation occurs. By repeated freezing the solution is gradually weakened and the freezing temperature raised, which would make the apparatus unsuitable for the purpose intended.

An example will probably help make the problem understood better, and to enable one to follow me. An example: Find the amount of pipe required and the proper size of holdover tank for a meat-storage room located in the basement of a butcher shop. The refrigerating machine is operated 10 hours per day; size of room, 16 x 8 x 7 ft.; insulation, two layers of 2 in. corkboard; maximum temperature in basement, 75 deg. F.; maximum temperature on first floor, 85 deg. F.; temperature of ground, 65 deg. F.; daily supply of fresh meat received, about 1000 lb.; temperature of meat at arrival, about 45 deg. F.; room temperature, 35 deg. F.; heat transfer through insulation, approximately 1.75 B.t.u. per 1 deg. F. difference per sq. ft. per 24 hours. The heat that the piping must absorb if the machine is running 24 hours is the heat that leaks through the insulation plus that which must be taken out of the meat during the time the machine is operating.

The influx of heat into the room is as follows:

	B.t.u.
Floor, 16x8x1.75x(65 - 35 deg.)	5,880
Ceiling, 16x8x1.75x(85 — 35 deg.)	7,840
Walls, 2x(16 plus 8)x7x1.75(75 — 35 deg.)	23,520
Cooling of meat in 10 hours = 1,000x0.7x(45 — 35)x$\frac{24}{10}$ (0.7 is the specific heat of meat)	16,800
Total number of heat units to be extracted per 24 hours	54,040

Ten per cent. should be added to the amount given to take

care of the heat that enters the room when doors are opened. The amount, with this 10 per cent. added, equals 59,444 B.t.u., which is the number of B.t.u. per 24 hours.

Heat withdrawn per hour = 59,444 ÷ 24 = 2476 B.t.u.

Heat transfer for pipe to be assumed as 1.5 B.t.u. per hour per degree difference per square foot.

Temperature of the evaporating ammonia in the pipe is 0 deg. F., which corresponds to the suction pressure of 15 lb. gage.

One square foot of surface equals 2.3 lin.ft. of 1¼-in. pipe.

Total length of 1¼-in. pipe to be placed in the air for cooling room therefore amounts to $\frac{2476 \times 2.3}{1.5 \times (35 - 0)} = 108.5$ feet.

The foregoing amount of piping could be arranged in a coil five pipes high, placed along two walls of the room, but for practical reasons it is desirable to make this coil seven pipes high, as it is difficult to regulate the feed valve close enough to prevent wet gas from going over into the compressor and materially reducing the capacity of the compressor. Besides this, it is desirable to have a coil of ample surface during the time the brine is frozen in the morning, when most of the stored-up cold in the brine hold-over tank has disappeared. Another point in favor of a large cooling surface is that a higher suction pressure can be carried with a corresponding higher temperature to produce the same refrigerating effect than with a coil containing less surface.

As the plant is operated only 10 hours daily, some form of cold accumulator must be provided to take care of the temperature in the room during the 14 hours while no refrigeration is being produced from the refrigerating plant. This is done by means of a brine holdover tank and the brine in this tank must absorb the heat leaking through the walls, ceiling and floor, amounting to the following:

Through the floor	$\frac{5,880 \times 14}{24}$ =	3,430 B.t.u.
Through the ceiling	$\frac{7,840 \times 14}{24}$ =	4,580 B.t.u.
Through the walls	$\frac{23,520 \times 14}{24}$ =	13,710 B.t.u.
Total		21,720 B.t.u.

There are three points that govern the proper tank dimensions: First, there must be sufficient surface to adequately absorb the heat entering the room through the walls; second, there must be a sufficient volume of brine; third, it must be possible to freeze the brine during the time the machine is running. If the tank is of the proper dimensions to take care of the first requirement, it will as a rule, also be suitable for taking care of the other two requirements.

The heat to be absorbed by the tank per hour is $\frac{21,720}{14} = 1550$ B.t.u.

With a heat transfer of 1.5 B.t.u. per hour and a temperature of 12 deg. F., at which temperature the brine freezes or thaws, the surface of the tank figures out to be $\frac{1550}{1.5 \times (35 - 12)} = 44.9$ square feet.

A tank 15 ft. long, 4 in. wide and 18 in. high, has a surface of 46 sq.ft., the corrugation of the material not being considered.

At the beginning of this discussion we saw that when thawing, one pound of brine would be capable of absorbing 114.8 B.t.u., which is the latent heat per pound of frozen brine. In the present case we therefore will require $\frac{21,720}{114.8} = 189$ lb. of brine.

The weight of one cubic foot of brine is 70 lb., therefore the tank should contain about $\frac{189}{70} = 2.7$ cu.ft. of calcium-chloride solution, and 4.9 cu.ft. is available, when about 73 ft. of 1¼-in. pipe is placed in it.

The freezing time in hours, H, is figured according to the formula $H = \frac{28 \times t^2}{f}$ where t is the thickness of ice in inches. In this case t is the greatest thickness of the ice, or the distance from the cooling pipe to the point on the side of the tank midway between two of the cooling pipes (see Fig. 1). For the example outlined, the distance will be 1.67 in.; f = difference in temperature between cooling surface and freezing point; for our example this is 12 deg. F.

$$H = \frac{28 \times 1.67^2}{12} = 6.54 \textit{ hours}$$

The cross-section through the room, Fig. 2, gives a clearer idea of the proportions of the various pieces of apparatus. The dotted lines show the space required by a holdover tank with a strong calcium solution.

Water Shortage Threatened at Washington

One of the effects of the large increase in the population of the District of Columbia is the greater demand for water. The original water supply was obtained by gravity from the Potomac River, but a filtering system, completed several years ago, necessitated pumping the water from the gravity reservoir through the sand beds, by low-head centrifugal pumps, and after being filtered it is pumped into the city mains by high-pressure pumps. The capacity of the supply conduit has been estimated at 60,000,000 gal. per day, but the daily average at present is about 62,000,000 gal. As a means of relieving the shortage the public fountains, including those in the White House grounds, have been shut off.

Secretary Baker has communicated a suggestion to Congress that electric connection be made between the Capitol power plant and the Government Printing Office so that the former, using unfiltered water from the Anacostia River, can supply electric current to the Printing Office, presumably during the summer only, and in this way save the filtered water now used for condensing purposes in the latter plant. A large part of the 3,000,000 gal. now used daily in the Government Printing Office would thus be saved. This "tying in" of not only these two plants but the new plant being built at the foot of Fourteenth St., S. W., has long been contemplated, and Secretary Baker's recommendation seems to be a step in the right direction. A more comprehensive plan of interconnection contemplates high-tension connection with the Bennings plant of the Potomac Electric Co. at the eastern extreme and the Georgetown plant of the Capital Traction Co. at the western end of the city with the three large Government plants mentioned and also the navy yard plant.

New Marine Engineering School

The United States Shipping Board has opened its tenth free marine engineering school for the training of officers for the new merchant marine. The sessions will be held in Dickinson High School building, Jersey City. The school starts with 40 students, but new students may enroll at any time at the school or with John F. Lewis, 108 South Fourth St., Philadelphia, chief of the free Government navigation and marine engineering schools from Connecticut River to Cape May.

American citizens more than 19 years old, who have had experience as firemen, oilers, water-tenders, locomotive or stationary engineers, or apprentices to the machinist trade who have had three years' service on marine, stationary or locomotive engines and one year at sea, are eligible for free training.

Similar schools are being conducted by the Shipping Board with much success at Massachusetts Institute of Technology, Cambridge; Seamen's Church Institute, New York; Johns Hopkins University, Baltimore; The Bourse, Philadelphia; Armour Institute, Chicago; Case School of Applied Science, Cleveland; Tulane University, New Orleans; Univers[illegible] of California, Berkeley; and University of Washington, [illegible]ttle.

New York Municipal Civil Service Examination

The Municipal Civil Service Commission has announced two examinations—Inspector of Gas, Grade 2, and Stationary Engineer (Electric Pumping Station.) Applications will be received at Room 1400, Municipal Building, Manhattan, until July 9 and 12, at 4 p. m. Applicants must be at least 21 years of age, citizens of the United States and residents of the State of New York.

Duties of inspectors of gas are to inspect by chemical, photometric or other tests the candlepower, pressure, specific gravity and general quality of gas and to make such records and reports as may be required. Candidates should have had practical experience in the analysis and testing of gas, or should have completed at least a two years' course of instruction in chemistry in a college or technical school of recognized standing. The examination will consist of two subjects: Experience, 4; Technical, 6. Vacancies occur from time to time in the Department of Water Supply, Gas and Electricity. The position pays a salary of from $1200 to $1800.

Stationary engineers (electric pumping station) are required to operate and maintain the high-pressure pumping stations for fire service. These stations are operated electrically through high voltage supplied by private companies and must respond promptly and efficiently to the needs of the Fire Department. Incumbents are responsible for the station during their watch, including the employees, records and pressures. Candidates must have five years' experience in connection with the installation or operation of electric power plants as machinists, dynamo tenders, engineers or in similar capacity; two years of this time must be in the actual handling of high-tension apparatus. They must be familiar with centrifugal pumps, transformers, high-tension switchboard apparatus, motor-operated valves and other equipment in connection with the fire-service station. The examination will consist of two subjects: Technical, 6; Experience, 4. Vacancies occur from time to time in the Department of Water Supply, Gas and Electricity. Salary $5 per day.

For further information apply to the Municipal Civil Service Commission, New York City.

Coal-Distribution Plan

Plans for the distribution of coal within the various states have been formulated and put into operation by the United States Fuel Administration. This plan is designed to define the responsibility and authority vested in the state fuel administrators for the distribution of the coal allotted to their respective states, subject to general instructions issued from time to time from Washington. The War Industries Board will decide what consumers shall have preference in securing coal, but the United States Fuel Administration has been asked to assist in the compilation of complete preference lists.

The crux of the new distribution plan lies in the compilation of these preference lists. All consumers of coal, except domestic consumers, will be recorded under the following classifications: (a) Railroads; (b) Army and Navy, together with other departments of the Federal Government; (c) state and county departments and institutions; (d) public utilities; (e) retail dealers; (f) manufacturing plants on War Industries Board's Preference List; (g) manufacturing plants not on War Industries Board's Preference List. The first six classes will be given preference in coal shipments in coöperation with the plants of the War Industries Board.

The list of consumers entitled to preference as established by the War Industries Board will be obtained through a questionnaire sent to every manufacturing plant in the country using more than 500 tons of coal annually. This list when compiled, will be furnished to each Fuel Administration District Representative in the producing field which supply the various states, and with these lists to guide them, together with weekly reports which will be required from each manufacturing plant, the state and local fuel administrators and district representatives will give their particular attention to building up proper stocks of coal at all essential war plants.

Under this plan of distribution each consumer should arrange for shipments from the same source of supply as last year, if possible.

Mechanics Needed at Fort Sam Houston, Texas

The Government is in need of hundreds of automobile mechanics and men possessing qualifications making them desirable in and about automobile-repair industries. The repair shops at Fort Sam Houston are designated by the War Department to take care of the motor transportation south of Kansas and west of the Mississippi, which means that the great number of motor-driven vehicles involved in service within the confines of the territory mentioned are dependent upon these repair shops for overhauls.

The education and training of men for this class of service with the Army is one of the principal factors of the shops at Fort Sam Houston. Adequate instruction is given the men to qualify for service with mechanical units in this country and abroad.

There exists at this time urgent need of men who have had experience in the following trades: Auto repairer, battery repairman, blacksmith, carpenter, harnessmaker and helper, motor-vehicle inspector, machinist and helper, magneto repairer, mechanical engineer, auto-repair mechanic, mechanical woodworker, motorcycle repairer, painter, sheet-metal worker, plumber, tire repairer, automobile trimmer, welder, wheelwright, electrician.

Capt. W. H. Warrens, Q. M. R. C., Adjutant of Quartermaster Mechanical Repair Shop No. 304, at Fort Sam Houston, Texas, who is well known in and about the States of Oregon and Washington, when interviewed, stated that the opportunities open to men for service in this shop are beyond the comprehension of civilians. While it is well known that the Navy has had in operation training schools for a number of years past, the Army has never before operated training institutions such as the one at Fort Sam Houston, for the reason that the requirements of the Army in the past have been adequately met by adjunctive departments attached to corps or regiments.

Any man, whether in the draft age or otherwise, who has had experience along the lines indicated, is requested to write without delay to the Commanding Officer of Quartermaster Mechanical Repair Shop No. 304, Fort Sam Houston, Texas, who will furnish full particulars concerning pay, Government allowances, and other subject matter indicating opportunities that are open to men possessing qualifications making them desirable for duty with this organization.

Muscle Shoals Power Line Completed

When the officials of the Alabama Power Co. entered into a contract with the Government for the construction of a 90-mile transmission line from the power house in Walker County, Alabama, to the development work at Muscle Shoals, it called for the completion of the work by July 1, but the company was ready to turn on the power over a month ahead of this contract time limit.

The work of building this line, which extends from the western terminus of the Warrior plant of the Alabama Power Co. to Muscle Shoals, is said to be equivalent to building a railroad of equal mileage. It is built on H-frame structures and will carry 110,000 volts. With its completion the first step in the elaborate Government program for Muscle Shoals has been taken, and the Alabama Power Co. is now building a 30,000 kw. extension to the Warrior reserve steam plant, thus establishing a second terminal, to be completed by Oct. 1. If the same rate of speed is maintained in this new extension as was realized in building the 90-mile transmission line, the chances are that this work will also be completed ahead of time.

Pennsylvania State Convention N. A. S. E.

The nineteenth annual convention of the Pennsylvania State Association of the N. A. S. E. was held in Chester, June 20-21. The meetings of the delegates were held in Odd Fellows Hall, and the basement of this building was tastefully decorated and conveniently arranged for the use of the supply men in the display of power-plant equipment and engine-room supplies. There were thirty firms represented.

There were upwards of fifty delegates in attendance. The business of the convention was disposed of with harmony and dispatch. The treasurer's report showed that the organization is on a sound financial basis. The keynote of the convention was the conservation of coal and foods and the ever-ready help to the boys "over there."

The opening ceremonies took place on Thursday morning at 10 o'clock, with the local chairman, Thomas A. Brennan, presiding. He spoke of the immense shipbuilding plants and other war industries of Chester and of the great Baldwin Locomotive Works at Eddystone, an adjoining town. He was glad to meet the delegates and friends in Chester, the "beehive of industry." Senator W. C. Sproul, in the absence from the city of Mayor McDowel, welcomed the convention to the city and expressed the hope that their stay would be full of pleasure and profit and offered his help in every way toward reaching that end. Ernest Uff, state president, then appointed the necessary committees, and the meeting adjourned until the afternoon session at 2 o'clock.

On Thursday evening, at Odd Fellows Hall, there was an entertainment and dance, which was largely attended. There were auto trips through the city on Thursday and Friday afternoons for the ladies and a boat trip on the Delaware on Friday for everybody. On Friday evening the ladies enjoyed the theater, while the delegates held a smoker at the West End Yacht Club.

The election of state officers resulted as follows: F. B. Mallett, Sharon, president; S. M. Hall, Philadelphia, vice president; J. N. Calvert, Pittsburgh, secretary; T. M. Wilson, Philadelphia, treasurer; James D. Rostron, Chester, conductor; Charles A. Patterson, Pittsburgh, doorkeeper. Samuel B. Forse, national treasurer, acted as installing officer, assisted by W. J. Reynolds, past national president. The retiring state president, Ernest Uff, was presented a handsome gold badge, the gift of the delegates. The next place of meeting was left to the discretion of a committee composed of the state officers.

New Publications

VOCATIONAL EDUCATION FOR DISABLED SOLDIERS

The Federal Board for Vocational Education has just issued the "Evolution of National Systems of Vocational Education for Disabled Soldiers," being Bulletin No. 15 of the series of this board, of which Dr. C. A. Prosser is the director. Coming at this particular time, when the problem of what will be done with our own wounded and disabled men is of growing interest to the country generally, the bulletin has the value of timeliness, in addition to its worth as the only complete exposition of what other nations are doing for their own who are suffering disabilities as one of the fortunes of war. It contains material drawn from official sources abroad in a volume of 320 pages, illustrated with many photographs showing the progress made in other countries in refitting men to take up again the battle of civil existence. Copies may be had without cost upon application to the Federal Board for Vocational Education, Ouray Building, Washington, D. C.

Obituary

Dr. James Douglas, well-known mining engineer and for many years president of the Phelps-Dodge Corporation, died at his Spuyten Duyvil home, June 25, aged 81 years. He was a member of many scientific societies and was twice president of the American Institute of Mining Engineers.

Personals

C. G. Wilson, formerly connected with the New York City office of the Elliott Co., has been appointed district sales manager of the New England district, with headquarters in the Oliver Building, Boston, Mass.

C. A. Hall has been appointed manager of the electric light and power department of the Eastern Pennsylvania Railways, Pottsville, Penn., which property is operated by The J. G. White Management Corporation, New York.

Engineering Affairs

The Providence Engineering Society announces the following officers for 1917-18: President, George A. Carpenter; vice-presidents, John T. Frankenberg, James A. Hall, Warren B. Lewis; secretary, William A. Kennedy; treasurer, Albert E. Thornley; councillors for three years, William P. Field, Robert K. Lyons, Archie W. Merchant, Benjamin F. Waterman; librarian, Lloyd E. Baker; chairman of publication committee, Fred R. Inman.

The Fourth National Exposition of Chemical Industries will be held in the Grand Central Palace, New York, during the week of September 23 this year. Its advisory committee is composed of Charles H. Herty, chairman; Raymond F. Bacon, L. H. Baekeland, Ellwood Hendrick, Henry B. Faber, Bernard C. Heese, A. D. Little, Wm. H. Nichols, R. P. Perry, H. C. Parmelee, G. W. Thompson, F. J. Tone, T. B. Wagner and M. C. Whitaker. Dr. Bacon of this committee is now head of the Chemical Welfare Section of the National Army and a member of General Pershing's staff. The coming exposition will be the largest chemical exposition ever held, and it will be necessary to use four floors of the Grand Central Palace. The exposition is a wartime necessity and regarding it as such each exhibitor is planning his exhibit that it will be of the greatest benefit to the country through the men who visit it, all of whom are bent upon a serious purpose—that of producing war materials in large quantities and constantly increasing this production till the war has been won by the United States and its Allies. The program for the exposition is in preparation and will be a series of symposiums on the "Development of Chemical Industries in the United States, notably since July, 1914."

Miscellaneous News

Seattle Engineering School, Inc., will erect a three-story school building and garage 120 x 250 ft. on Queen Anne Ave. Sherwood D. Ford, Lyon Building, architect; William T. A. Faulkner, president. Catalogs of steam, gas and electrical-engineering equipment are desired.

New Construction

Proposed Work

Mass., Peabody—The A. C. Lawrence Leather Co., Crownshield St., has had plans prepared for the erection of a 1-story addition to its power plant. A. E. Bump, 60 North Market St., Boston, Arch.

N. Y., Buffalo—The Strong Steel Co., 33 Norris St., is in the market for motors, belting and shafting, in connection with the erection of a 1-story, 80 x 300 foundry and machine shop. Total cost, $75,000.

N. Y., Brooklyn—The Weiss Amusement Co., 1063 Manhattan Ave., plans to install a steam heating system in its proposed 1-story, 50 x 100 ft. theater. Boilers and radiators will be required.

N. Y., Rochester—The Bridgeford Tool and Machine Works, Winton Rd., is considering the erection of a new power house in connection with its plant.

N. J., Camden—Warren & Webster Co., Point and Pearl St., will soon award the contract for the installation of heating, lighting and plumbing systems in connection with the proposed 2-story, 43 x 71 ft. factory. Ballinger & Perrot, 17th and Arch St., Philadelphia, Penn., Arch. Noted Feb. 5.

N. J., Jersey City—The Board of Freeholders, Hudson Co., will soon receive bids for the construction of a new power plant. Estimated cost, $500,000. P. A. Vivaritas, 110 4th St., Union Hill, Arch. Noted Feb. 8.

N. J., Newark—The American Oil and Supply Co., 52 Lafayette St., will soon receive bids for the installation of heating, lighting and plumbing systems in the proposed 1- and 2-story, 60 x 300 ft. warehouse.

N. J., Passaic—The New York Belting and Packing Co., 91 Chambers St., New York City, plans to build a 1-story, 60 x 150 ft. power house here. Plans include the erection of a 1-story, 30 x 75 ft. brick and steel pump house. Lockwood, Greene and Co., 101 Park Ave., New York City, Arch.

Penn., Philadelphia—The Gosa Brockman Co., 12 North 5th St., will soon award the contract for the installation of a heating and plumbing system in the proposed 1-story, 60 x 62 ft. machine shop on 11th and Schiller St.

Penn., Philadelphia—The Miller Chemical Co., Delaware Ave. and Mifflin St., plans to improve its power plant.

Penn., Sharon—The Savage Arms Co., 50 Church St., New York City, plans to build a 40 x 60 ft. addition to its power plant here. Griggs & Myers, 110 West 40th St., New York City, Engrs.

Penn., West Reading—The Narrow Fabric Co., Wyoming, will soon award the contract for the installation of a heating and electric lighting system in its proposed 5-story, 104 x 222 ft. factory here.

Wash., D. C.—Bids will be received by the Bureau of Supplies and Accounts, Navy Dept., for equipment as follows:

July 5—Motors, shafting, etc.; Schedule No. 4804½, delivery Indian Head, Md.

Shapers, Schedule No. 4807½, delivery Brooklyn, N. Y.

July 8—Pumps, Spec. No. 4805½, delivery f.o.b. Washington, D. C.

Engine lathes, Schedule No. 4778½; air hoists, Schedule No. 4788½, delivery Navy Yard, Wash., D. C.

Tool grinders, Schedule No. 4786½, delivery Navy Yard, Phila., Pa.

Wash., D. C.—Bids were received by the Bureau of Supplies and Accounts, Navy Dept., for furnishing equipment as follows:

(Item 1) 1 motor, 24 hp. a.c. 229 volt, 3 phase, 25 cycle, 1200 r.p.m. from the Bure Electric Co., Erie, Penn., $556, alternate, $596; the Century Electric Co., 19th and Pine Sts., St. Louis, Mo., $548; alternate, $495; the Ideal Electric Co., 153 East 5th St., Mansfield, Ohio, $570; the Lincoln Electric Co., Woodward Bldg., $548; the Mechanical Appliance Co., 133 Stewart St., Milwaukee, Wis., $540; Roth Bros. & Co., 1400 West Adams St., Chicago, $622; the Reliance Electric and Eng. Co., 90 West St., New York City, $601; the Wagner Electric Manufacturing Co., 6400 Plymouth St., St. Louis, Mo., $522; the Westinghouse Electric Co., Hibbs Bldg., $574; the U. S. Electric Manufacturing Co., 459 East 3rd St., Los Angeles, Calif., $571.

Va., Norfolk—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., will soon award the contract for the erection of a power house and the installation of a generating plant piping, etc., at the Hospital Reservation.

W. Va., Tallmansville—The Franklin Coal Co., Commercial Trade Bldg., Philadelphia, Penn., plans to install a large electric lighting and power plant with necessary equipment in its mine here. Estimated cost, $20,000.

N. C., Raleigh—The City is in the market for a 5,000,000 gal. steam, turbine-driven centrifugal pump and a 4,000,000 gal. motor-driven centrifugal pump.

Tenn., Coal Creek—The Magnet Knitting Mills plans to install a power plant in connection with the new mills.

Ky., Louisville—The Board of Waterworks is in the market for a new 30,000,000 to 40,000,000 gal. pumping engine for the Crescent Hill plant and a new boiler plant, coal handling plant, new equipment, etc., in connection with the power improvements in the Riverside Station.

Ohio, Akron—The Eagles Home Co., East Market St., will soon receive bids for the installation of heating, electric lighting and plumbing systems in the proposed 3-story, 66 x 162 ft. club and office building.

Ohio, Sandusky—The City is in the market for 2 boilers. Estimated cost, $18,000. A. F. Johnson, City Engr.

NInd., Whiting—The City plans to install a one 5,000,000 gal. centrifugal pump in connection with its proposed water filtration plant. Total cost, $130,000. S. A. Greely, 64 West Randolph St., Chicago, Engr.

Mich., Grand Rapids—The Holland Furniture Co. is having plans prepared by the Wernette-Bradfield-Mead Co., Engr., 441 Houseman St., for remodeling its power plant.

Ill., Peoria—The Palatine Lead and Zinc Mining Co., Miami, will build a concentration plant and install belts, conveyors, etc., in same. Estimated cost, $60,000. E. L. Warner, Mgr.

Wis., Modena—C. Schmidlin has retained the Power Eng. Co., Engr., Corn Exchange, Minneapolis, Minn., to prepare plans for improvements to its hydroelectric and milling plant.

Iowa, Ottumwa—The Chicago, Milwaukee and St. Paul Ry., Ry. Ex. Bldg., Chicago, plans to improve its terminal facilities here. Work includes the construction of a boiler house, etc., and the installation of an 85 ft. electric turn table, etc. C. F. Loweth, Chicago, Ch. Engr.

Minn., Duluth—The Board of Education will soon award the contract for the installation of heating, ventilating and electrical equipment in connection with the proposed E. R. Cobb School addition. Croft & Boerner, Lonsdale Bldg., Engr.

Kan., Augusta—The City is having plans prepared by Black & Veatch, Engr., Interstate Bldg., Kansas City, Mo., for the erection of a power plant here. Estimated cost, $75,000.

Kan., Baxter Springs—The City is in the market for 2 compressors to furnish power to the water-works plant. Estimated cost, $6000. O. W. Fail, City Clerk.

Kan., Ellis—The City voted $30,000 bonds for improvements to its electric lighting plant. Black & Veatch, Interstate Bldg., Kansas City, Mo., Engr.

Neb., Belvidere—The City is in the market for the following equipment in connection with its proposed distribution system: three 10 kw. 13,200-2200 volt, 3 phase, 60 cycle pole type transformers, 80 kw. 2200-110-220 volt, 3-phase, 60 cycle pole type transformers, all provided with oil hangers and blocks, one 5 kw. series transformer with panel and instruments for 6.6 ampere circuit transformer station, etc. Estimated cost, $5500. C. F. Sturtevant, Holdredge, Engr.

S. D., Huron—The Farmers' Co-operative Packing Co., plans to build a 1 story, 85 x 91 ft. power house. Packers Architect and Engineering Co., 431 South Dearborn St., Chicago, Ill., Arch. and Engr.

S. D., Pierre—City plans to install a new electric lighting plant to replace the one recently destroyed by fire. J. A. Rose, Auditor.

Mo., Jefferson City—The Hays Wood Product Co. plans to build a power house in connection with its factory. Estimated cost, $20,000.

Mo., Joplin—The Kirkwood Mining Co., 12 Cuningham Bldg., will remodel its concentration plant and install motors, etc., in same. Estimated cost, $40,000. S. A. Smith, Supt.

Mo., Joplin—The Piachard and Clear Mining Co., Cunningham Bldg., will remodel its mill and build a concentration plant. New equipment including boilers, conveyors, etc., will be installed in same. Estimated cost, $26,000. F. Clear, Supt.

Mo., Pleasant Hill—The Green Light and Power Co. plans to extend its electric system to Archie.

Mo., Rich Hill—The City voted $14,000 bonds for enlarging and improving the electric lighting and water-works system. A. Moore, Mayor.

Ark., Ft. Smith—The Arkansas Mining and Mercantile Co. will build a concentration plant. Equipment including engines, boilers, belts, etc., will be installed. Estimated cost, $60,000. F. A. Handlin, Mgr.

Ark., Zinc—The Consolidated Zinc Mines Co., Searcy Co., is in the market for air compressors, engines, boilers, conveyors, etc., for installation in its proposed concentration plant. Total cost, $70,000. N. W. Palmer, Muskogee, Okla., Supt.

Okla., Baxter Springs—City voted $85,000 bonds for the erection of a water works plant and system. Engines, boilers, etc., will be installed in the plant. O. W. Fail, City Clk.

Okla., Douthat—The Douthat Miami Mining Co., will build a concentration plant near here. Equipment including engines, boilers, belts, etc., will be installed in same. Total cost, $60,000. C. Douthat, Cardin, Supt.

Okla., Miami—The Aurora Mining Co. is in the market for motors, air compressors, belts, conveyors, etc., for its concentration plant which is being constructed east of Leadville. Estimated cost, $60,000. J. W. Hale, Supt.

Okla., Peoria—The Nebo Lead and Zinc Co. will build a concentration plant. Equipment including air compressors, engines, boilers, belts, conveyors, etc., will be installed in same. Estimated cost, $60,000. R. C. Croslin, Supt.

Tex., Laredo—The Laredo Electric & Street Ry. plans to improve its electrical plant.

CONTRACTS AWARDED

Conn., New Haven—The Eastern Machine Screw Co., Trumm St., is building a 1-story, brick boiler house addition to its plant.

N. Y., Buffalo—The Donner Steel Co., 475 Abbott Rd., will build a 1000 hp. plant in connection with the proposed coke plant. Total cost, $3,000,000. H. Koppers Co., O'Hara St., Pittsburgh, Penn., Engr.

N. J., Passaic—The New Jersey Belting and Packing Co., 91 Chambers St., New York City, is building a power house here.

Penn., Philadelphia—The Ludwig Fritz Commercial Products Co. has awarded the contract for the erection of a 1-story, 30 x 60 ft. power plant on State and Robbins St., to A. Ahlers, 3425 Howell St.

Penn., Williamsport—The Lycoming Rubber Co. has awarded the contract for the erection of a 1-story, 87 x 87 ft. brick and steel power house, to the McNalley Building Co., 41 Concord St., Framingham, Mass. Noted Mar. 12.

Penn., York Haven—The York Haven Water and Power Co. has awarded the contract for the reconstruction and completion of a power dam over the east channel of the Susquehanna River between the Lancaster Co. shore and Four Mile Island, to G. W. Ensign, Inc., Harrisburg Bank Bldg., Harrisburg. Estimated cost, $10,000; cost plus 15 per cent.

Ill., Chicago—The Trustees of the Sanitary District, 910 South Michigan Ave., have awarded the contract for the erection and equipment of the Calumet Sewage Pumping Station, to T. J. Forschner Contg. Co., West Pullman, Chicago. Estimated cost, $724,000 on work under Div. A except item 18, the Sanitary District to pay half of the cost of the work in excess of this amount up to $905,278, the amount of the original bid; the contractor to credit the Sanitary District with half of the difference between $724,000 and the actual cost in case it is less than this figure; furnishing 6 pumps in Div. B, $254,300, 72 in. pump, $46,000 (this one to be optional with the Sanitary Dist.); 8 motors in Div. C., $120,000; switchboard, etc., Div. D, $49,495. Noted June 25.

Colo., Sterling—School District No. 12 has awarded the contract for the installation of heating and plumbing in its proposed 2 story, 151 x 197 ft. school on Division Ave., to Johnson & Davis, 427 15th St. Estimated cost, $13,905.

Wis., Stevens Point—The Automatic Cradle Co. has awarded the contract for the erection of a 43 x 63 ft., brick and concrete power house, to F. Spalenka, Steven Point. Estimated cost, $11,000.

Wash., Seattle—The Puget Sound Traction, Light and Power Co., 14th Ave., has awarded the contract for the erection of a power station in South Seattle, to the Stone and Webster Eng. Corp., 7th and Olive St. Estimated cost, $30,000.

Calif., San Francisco—The Board of Public Works has awarded the contract for furnishing and delivering electric locomotives at the Hetchy Hetchy site, to the General Electric Co., Rialto Bldg. Estimated cost, $39,162

THE COAL MARKET

Boston—Current quotations per gross ton f.o.b. mines are **as follows:**

ANTHRACITE

	Circular Current
Buckwheat	$3.40
Rice	2.90
Boiler	2.65
Barley	2.40

All-rail rate to Boston is $2.86.

BITUMINOUS

Bituminous, $8 to $8.75.

Pocohontas and New River, f.o.b. Boston, $8.35 to $8.90.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* are as follows:

	Circular	Individual
Pea	$5.20	$5.95
Buckwheat	5.15	5.90
Rice	4.65	5.10
Barley	4.15	4.30
Boiler	4.60	....
Broken	6.75	7.50
Egg	6.35	7.10
Stove	6.60	7.35
Chestnut	6.70	7.45

Quotations for domestic coals at the upper ports are 5c. higher on account of the difference in freight rates. Prices for buckwheat, rice, barley and boiler are not fixed by the Government.

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty, Hoboken, Weehawken, Edgewater or Cliffside and Gutenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The ratte to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	Current	One Yr. Ago	Current	One Yr. Ago
Pea	$3.45	$3.10	$4.60	$4.00
Barley	2.40	1.90	3.30	2.15
Buckwheat	3.40	2.90	4.55	3.80
Rice	2.90	2.40	3.80	3.40
Boiler	2.70	2.20	3.70	3.30

Chicago—Steam coal prices f.o.b. mines:

	Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes	$2.55—2.70		$3.25—3.40
Mine-run	2.35—2.50		3.00—3.15
Screenings	2.05—2.20		2.75—2.90

St. Louis—Prices per net ton f.o.b. mines are as follows:

	Williamson and Franklin Counties	Mt. Olive & Staunton	Standard
6-in. lump	$2.55-2.90	$2.55-2.70	$2.40-2.70
2-in. lump	2.55-2.90	2.55-2.70	2.40-2.70
Steam egg	....	....	2.40-2.70
Mine-run	2.35-2.50	2.35-2.50	1.85-2.00
No. 1 nut	2.55-2.90	2.55-2.70	....
2-in. screen	2.05-2.20	2.05-2.20	....
No. 5 washed	2.05-2.20	2.05-2.20	1.25-1.50

Williamson-Franklin rate to St. Louis is $1.10, other rates, $0.95.

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Lump & Nut	Slack and Screenin
Big Seam	$2.05	$2.35	$1.75
Pratt, Jagger	2.25	2.55	1.95
Corona	2.30	2.65	1.95
Black Creek, Cahaba	2.75	3.00	2.35

Government figures.

Individual prices are the company circulars to which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same the s periods of the year and are fixed a ding t schedule

PRICES—MATERIALS AND SUPPLIES

These are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

ELECTRICAL SUPPLIES

SWITCHES, KNIFE—

TYPE "C" NOT FUSIBLE

Size, Amp.	Single Pole, Each	Double Pole, Each	Three Pole, Each	Four Pole Each
30	$0.42	$0.68	$1.02	$1.36
60	.74	1.22	1.84	2.44
100	1.50	2.50	3.76	5.00
200	2.70	4.50	6.76	9.00

TYPE "C" FUSIBLE, TOP OR BOTTOM

30	.70	1.06	1.60	2.12
60	1.18	1.80	2.70	3.60
100	2.38	3.66	5.50	7.30
200	4.40	6.76	10.14	13.50

Discounts:

Less than $10.00 list value	5%
$10 to $25 list value	16%
$25 to $50 list value	24%
$50 to $200 list value	28%
$200 list value or over	31%

RUBBER-COVERED COPPER WIRE—Per 1000 ft. in New York:

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Duplex
14	$11.00	$12.50	$15.00	$24.25
12	14.23	16.92	19.48	32.25
10	16.92	22.83	25.81	45.00
8	27.65	31.40	35.50	61.00
6	.....	.....	56.00	.....
4	.....	.....	76.40	.....
2	.....	.....	112.45	.....
1	.....	.....	152.26	.....
0	.....	.....	182.90	.....
00	.....	.....	223.60	.....
000	.....	.....	271.24	.....
0000	.....	.....	332.40	.....

WIRE, ANNUNCIATOR AND DAMPPROOF OFFICE—

No. 18 B.&S. regular spools (approx. 8 lb.)	46c. lb.
No. 18 B.&S. regular 1-lb. coils	47c. lb.

WIRING SUPPLIES—

Friction tape, ¾ in., less 100 lb. 40c. lb., 100 lb. lots	38c. lb.
Rubber tape, ¾ in., less 100 lb., 48c. lb., 100 lb. lots	45c. lb.
Wire solder, less 100 lb. 50c. lb., 100 lb. lots	46c. lb.
Soldering paste, 2 oz. cans Nokorode	$1.20 doz.

ARMORED CABLE—

B.&S. Size	Two Cond. M Ft.	Three Cond. M Ft.	Two Cond. Lead M Ft.	Three Cond. Lead M Ft.
No. 14 solid	$104.00	$138.00	$164.00	$222.00
No. 12 solid	135.00	170.00	211.00	290.00
No. 10 solid	185.00	235.00	255.00	325.00
No. 8 stranded	235.00	325.00	345.00	450.00
No. 6 stranded	370.00	472.00	625.00	.....

From the above lists discounts are:

	Net List
Less than coil lots	10%
Coils to 1,000 ft.	15%
1,000 ft. and over	

BATTERIES, DRY—Regular No. 6 size red seal, Columbia, or Ever Ready:

	Each, Net
Less than 12	$0.40
12 to 50	.35
50 to 125 (bbl.)	.31
125 (bbl.) or over	.28

CONDUITS, ELBOWS AND COUPLINGS—Following are warehouse net prices per 1000 ft. for conduit and per unit for elbows and couplings:

In.	Conduit— Enameled	Conduit— Galvanized	Elbows— Enameled	Elbows— Galvanized	Couplings— Enameled	Couplings— Galvanized
½	$66.56	$71.66	$0.1602	$0.1716	$0.059	$0.0632
¾	87.75	94.65	.2108	.2258	.0843	.0903
1	129.71	139.91	.3119	.3341	.1096	.1174
1¼	175.49	189.29	.4019	.4289	.1518	.162
1½	209.83	226.33	.5358	.5718	.1875	.2001
2	282.31	304.51	.9823	1.05	.25	.2668
2½	446.36	481.46	1.61	1.71	.3572	.3812
3	583.70	629.60	4.28	4.57	.5358	.5718
3½	729.56	784.76	9.47	10.10	.7144	.7624
4	886.17	951.57	10.93	11.67	.893	.953

From New York Warehouse—Less 5% cash.

Standard lengths rigid, 10 ft. Standard lengths flexible, ½ in., 100 ft. Standard lengths flexible, ¾ to 2 in., 50 ft.

CONDUIT NON-METALLIC, LOOM—

Size I. D., In.	Feet per Coil	List, Ft.
⅜	250	$0.05½
½	250	.06
¾	250	.09
⅞	200	.12
1	200	.15
1¼	150	.18
1½	100	.25
1¾	100	
1¾	Odd lengths	
2	Odd lengths	

Coils 55% Off.
Less coils, 40% off

FLEXIBLE CORD—Price per 1000 ft. in coils of 250 ft.:

No. 18 cotton twisted	$20.00
No. 16 cotton twisted	24.50
No. 18 cotton parallel	21.00
No. 16 cotton parallel	28.00
No. 18 cotton reinforced heavy	28.50
No. 16 cotton reinforced heavy	38.00
No. 18 cotton reinforced light	24.00
No. 16 cotton reinforced light	32.00
No. 18 cotton Canvasite cord	25.00
No. 16 cotton Canvasite cord	32.00

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS, PLUG

S. P. M. L.	$0.11	T. P. to D. P. S. B.	$0.24
D. P. M. L.	.18	T. P. to D. P. T. B.	.38
T. P. M. L.	.26	T. P. S. B.	.33
D. P. S. B.	.19	T. P. D. B.	.54
D. P. D. B.	.37		

CUT-OUTS, N. E. C. FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.33	$0.84	$1.68
T. P. M. L.	.48	1.20	2.40
D. P. S. B.	.42	1.05	.....
T. P. S. B.	.81	1.80	.....
D. P. D. B.	.78	2.10	.....
T. P. D. B.	1.35	3.60	.....
T. P. to D. P. D. B.	.90	2.52	.....

FANS—Following are prices of fans in New York:

DIRECT CURRENT

6 in.—Universal D. C. and A. C. Diehl	$ 6.00
9 in.—110 volt D. C. S&T Diehl or Sprague	11.00
9 in.—110 volt D. C. Osc. Diehl or Sprague	13.75
12 in.—110 volt D. C. S&T Diehl or Sprague or Eck	14.50
12 in.—110 volt D. C. Osc. Diehl or Sprague or Eck	18.55
16 in.—110 volt D. C. S&T Diehl or Sprague or Eck	17.25
16 in.—110 volt D. C. Osc. Eck or Sprague	21.25

ALTERNATING CURRENT

9 in.—110 volt 60 cycle A. C. S&T Diehl or Sprague	$11.00
9 in.—110 volt 60 cycle A. C. Osc. Diehl or Sprague	14.00
12 in.—110 volt 60 cycle A. C. S&T Diehl or Sprague	14.75
12 in.—110 volt 60 cycle A. C. Osc. Diehl or Sprague	19.50
16 in.—110 volt 60 cycle A. C. S&T Diehl or Sprague	18.25
16 in.—110 volt 60 cycle A. C. Osc. Diehl or Sprague	22.50

For 220 volt Winding—$1.00 additional

These prices are for fans 6 or more, less than this quantity add 10%.

FUSES, ENCLOSED—

250-Volt	Std. Pkg.	List
3-amp. to 30-amp.	100	$0.25
35-amp. to 60-amp.	100	.35
65-amp. to 100-amp.	50	.90
110-amp. to 200-amp.	25	2.00
225-amp. to 400-amp.	25	3.60
450-amp. to 600-amp.	10	5.50
600-Volt		
3-amp. to 30-amp.	100	.40
35-amp. to 60-amp.	100	.60
65-amp. to 100-amp.	50	1.50
110-amp. to 200-amp.	25	2.50
225-amp. to 400-amp.	25	5.50
450-amp. to 600-amp.	10	8.00

Discount: Less 1-5th standard package 30%
1-5th to standard package 40%
Standard package 52%

FUSE PLUGS, MICA CAP—

0–30 ampere, standard package	$4.20 C
0–30 ampere, less than standard package	5.00 C

LAMPS—Below are present quotations in less than standard package quantities:

Straight-Side Bulbs Mazda B— Watts	Plain	Frosted	No. in Package	Pear-Shape Bulbs Mazda C— Watts	Clear	Frosted	No. in Package
10	0.30	$0.33	100	75	$0.70	$0.75	50
15	.30	.33	100	100	1.10	1.15	24
25	.30	.33	100	150	1.65	1.70	24
40	.30	.33	100	200	2.20	2.27	24
50	.30	.33	100	300	3.25	3.35	24
60	.35	.39	100	400	4.30	4.45	12
100	.70	.77	24	500	4.70	4.85	12
				750	6.50	6.75	8
				1000	7.50	7.75	8

Standard quantities are subject to discount of 10% from list. Annual contracts ranging from $150 to $300,000 net allow a discount of 17 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Hubbell, porcelain No. 5406, standard package 250	$0.21
Hubbell composition No. 5467, standard package 50	.28
Benjamin swivel No. 903, standard package 250	.15
Hubbell current taps No. 5638, standard package 50	.35

SOCKETS, BRASS SHELL—

½ In. or Pendant Cap. Key, Each	Keyless, Each	Pull, Each	⅜ In. Cap Key, Each	Keyless, Each	Pull, Each
$0.33	$0.30	$0.60	$0.39	$0.36	$0.66

Less 1-5th standard package	10%
1-5th to standard package	8%
Standard package	25%

MISCELLANEOUS

HOSE—

	Fire 50-Ft. Lengths
Underwriters' 2½-in.	75c. per ft.
Common, 2½-in.	33⅓%

	Air First Grade	Second Grade	Third Grade
¾-in. per ft.	$0.60	$0.35	$0.30

Steam—Discounts from List

First grade..... 25% Second grade.....30% Third grade.....40%

RUBBER BELTING—The following discounts from list apply to transmission rubber and duck belting:

Competition..... 40% Best grade..... 15%
Standard..... 30%

Note—Above discounts apply on old list. New list issued July 1.

LEATHER BELTING—Present discounts from list in the following cities are as follows:

	Medium Grade	Heavy Grade
New York	40%	35%
St. Louis	45%	40%
Chicago	30+10%	40+5%
Birmingham	35%	35%
Denver	35%	30%

RAWHIDE LACING—40%.

PACKING—Prices per pound:

Rubber and duck for low-pressure steam	$0.99
Asbestos for high-pressure steam	1.76
Duck and rubber for piston packing	1.10
Flax, regular	.99
Flax, waterproofed	1.21
Compressed asbestos sheet	1.10
Wire insertion asbestos sheet	1.32
Rubber sheet	.66
Rubber sheet, wire insertion	.99
Rubber sheet, duck insertion	.33
Rubber sheet, cloth insertion	.25
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.21
Asbestos wick, ½- and 1-lb. balls	.75

PIPE AND BOILER COVERING—Below are discounts and part of standard lists:

PIPE COVERING

Pipe Size	Standard List Per Lin.Ft.
1-in.	$0.27
2-in.	.36
6-in.	.80
4-in.	.60
3-in.	.45
8-in.	1.10
10-in.	1.30

85% magnesia high pressure..... 5% off

For low-pressure heating and return lines { 4-ply..... 58% off; 3-ply..... 60% off; 2-ply..... 62% off

BLOCKS AND SHEETS

Thickness	Price per Sq.Ft.
½-in.	$0.27
1-in.	.30
1½-in.	.45
2-in.	.60
2½-in.	.75
3-in.	.90
3½-in.	1.05

GREASES—Prices are as follows in the following cities in cents per pound for barrel lots:

	Cincinnati	Chicago	St. Louis	Birmingham	Denver
Cup	7	5¼	13	7½	12
Fiber or sponge	8	6	13	7½	20
Transmission	7	6	13	7½	20
Axle	4½	4	3.8	4	5½
Gear	4½	4½	7.0	4½	9
Car journal	22 (gal.)	3½	4.3	7½	8

COTTON WASTE—The following prices are in cents per pound:

	New York Current	New York One Year Ago	Cleveland	Chicago
White	11.00 to 13.00	13.00	16.50	12.00 to 16.50
Colored mixed	8.50 to 12.00	10.00	13.00	11.50 to 14.00

WIPING CLOTHS—Jobbers' price per 1000 is as follows:

	13¼ x 13¼	13¼ x 20½
Cleveland	$52.00	$58.00
Chicago	48.00	50.00

LINSEED OIL—These prices are per gallon:

	New York Current	New York One Year Ago	Cleveland Current	Cleveland One Year Ago	Chicago Current	Chicago One Year Ago
Raw per barrel	$1.65*	$1.31	$1.75	$1.32	$1.70	$1.32
5-gal. cans	1.75*	1.41	1.90	1.42	1.90	1.37

WHITE AND RED LEAD in 500-lb. lots sell as follows in cents per pound:

	Red Current Dry	Red Current In Oil	Red 1 Year Ago Dry	Red 1 Year Ago In Oil	White Current 1 Yr. Ago Dry and In Oil
25- and 50-lb. kegs	12.38	12.83	12.25	10.50	12.38	12.00
12½-lb. keg	12.60	13.05	12.50	10.75	12.60	12.25
100-lb. keg	12.15	12.29	12.75	11.00	12.15	12.50
5-lb. cans	13.95	.....	14.25	12.60	13.95	13.50
1-lb. cans	14.85	.....	.....	.....	14.85	.....

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

	New York	Cleveland	Chicago
Steel ⅞ and smaller	30%	45-5	45%
Timned	30%	45-5	45%

Button heads, ¾, ⅞, 1 in. diameter by 2 in. to 5 in. sell as follows per 100 lb.:

New York...$6.09½ Cleveland...$5.15 Chicago....$5.50 Pittsburgh...$4.65

Coneheads, same sizes:

New York...$6.19½ Cleveland...$5.25 Chicago....$5.60 Pittsburgh...$4.75

REFRACTORIES—Following prices are f. o. b. works, Pittsburgh:

Chrome brick	net ton	$175.00
Chrome cement	net ton	75.00
Clay brick, 1st quality fireclay	per 1000	50.00–55.00
Clay brick, 2nd quality	per 1000	35.00–40.00
Magnesite, raw	ton	30.00–35.00
Magnesite, calcined	ton	32.00–35.00
Magnesite, dead burned	net ton	32.00–35.00
Magnesite brick, 9 x 4½ x 2½ in.	net ton	110.00–125.00
Silica brick	per 1000	50.00–60.00

Standard size fire brick, 9 x 4½ x 2½ in. The second quality is $4 to $5 cheaper per 1000.

St. Louis—High grade, $55; St. Louis grade, $40.
Birmingham—Fire clay, $55-60; silica, $55-60.
Chicago—Second quality, $25 per ton.
Denver—Silica, $35 per 1000.

BABBITT METAL—Warehouse prices in cents per pound:

	New York Current	New York One Year Ago	Cleveland Current	Cleveland One Year Ago	Chicago Current	Chicago One Year Ago
Best grade	125.00	70.00	113.00	73.00	100.00	70.00
Commercial	70.00	40.00	23.00	22.00	22.00	30.00

SWEDISH (NORWAY) IRON—The average price per 100 lb., in ton lots, is:

	Current	One Year Ago
New York	$16–19	$20.00
Cleveland	20.00	12.30
Chicago	17.00	12.00

In coils an advance of 50c. usually is charged.
Note—Stock very scarce generally.

POLES—Prices on Western red cedar poles:

	New York	Chicago	St. Louis	Denver
6 in. by 30 ft.	$5.59	$4.94	$4.94	$4.32
7 in. by 30 ft.	7.40	6.60	6.60	5.80
7 in. by 35 ft.	10.70	9.60	9.60	8.55
8 in. by 35 ft.	12.20	10.90	10.90	9.65
7 in. by 40 ft.	12.35	11.00	11.00	9.75
8 in. by 40 ft.	13.75	12.15	12.15	10.65
8 in. by 45 ft.	18.20	16.20	16.20	14.30
8 in. by 50 ft.	21.85	19.45	19.45	17.15

10c. higher freight rates on account of double loads.
For plain pine poles, delivered New York, the price is as follows:

10-in. butts, 5-in. tops, length 20-30 ft.	$9.00
12-in. butts, 6-in. tops, length 30-40 ft.	11.50
12-in. butts, 6-in. tops, length 41-50 ft.	12.50
14-in. butts, 6-in. tops, length 51-60 ft.	21.00
14-in. butts, 6-in. tops, length 61-71 ft.	23.50

PIPE—The following discounts are for carload lots f. o. b. Pittsburgh, basing card in effect July 2, 1917, for iron, and May 1 for steel:

BUTT WELD

Inches	Steel Black	Steel Galvanized	Inches	Iron Black	Iron Galvanized
¼ to 3	49%	35½%	¼ to 1½	33%	17%

LAP WELD

2	42%	29½%	2	26%	12%
2½ to 6	45%	32½%	2½ to 4	28%	15%
7 to 12	42%	28½%	4½ to 6	28%	15%
13 and 14	32½%	.....	7 to 8	20%	8%
15	30%	.....			

BUTT WELD. EXTRA STRONG PLAIN ENDS

¼ to 1½	47%	34½%	¼ to 1½	33%	18%
2 to 3	48%	35½%			

LAP WELD. EXTRA STRONG PLAIN ENDS

2	40%	28½%	2	27%	14%
2½ to 4	43%	31½%	9 to 12	15%	3%
4½ to 6	42%	30½%	7 to 12	25%	12%
7 to 8	38%	24½%	2½ to 4	29%	17%
9 to 12	33%	19½%	4½ to 6	28%	16%

From warehouses at the places named the following discounts hold for steel pipe:

	Black New York	Black Chicago	Black St. Louis
¼ to 3 in. butt welded	33%	42%	34.27%
3½ to 6 in. lap welded	15%	38%	21.27%

	Galvanized New York	Galvanized Chicago	Galvanized St. Louis
¼ to 3 in. butt welded	16%	22%	19.27%
3½ to 6 in. lap welded	+3	18%	13.27%

Malleable fittings, Class B and C, from New York stock sell at +5 from list prices. Cast iron, standard sizes, 10 and 5%.

BOILER TUBES—The following are the prices for carload lots f.o.b. Pittsburgh, announced Nov. 13, as agreed upon by manufacturers and the Government:

Lap Welded Steel		Charcoal Iron	
3½ to 4½ in.	34	3½ to 4½ in.	12½
2½ to 3½ in.	24	3 to 3½ in.	+ 5
2½ in.	17½	2½ to 2¾ in.	+ 7½
1¾ to 2 in.	13	2 to 2½ in.	+22½
		1¼ to 1½ in.	+35

Standard Commercial Seamless—Cold drawn or hot rolled

	Per Net Ton		Per Net Ton
1 in.	$340	1½ in.	$220
1¼ in.	280	2 to 2½ in.	190
1⅜ in.	270	2¾ to 3¾ in.	180
1½ in.	220	4 in.	200
		4½ to 5 in.	220

These prices do not apply to special specifications for locomotive tubes nor special specifications for tubes for the Navy Department, which will be subject to special negotiation.